NASA/SP—1998–7037/SUPPL390
December 25, 1998

# AERONAUTICAL ENGINEERING

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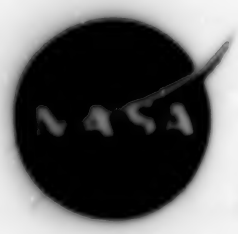

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Includes passenger and cargo air transport operations; and aircraft accidents.

04 Aircraft Communications and Navigation 8

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

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Includes aircraft simulation technology.

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Includes cockpit and cabin display devices; and flight instruments.

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Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.

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18 Space Sciences 32

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

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# Typical Report Citation and Abstract


- 19970001126 NASA Langley Research Center, Hampton, VA USA
- Water Tunnel Flow Visualization Study Through Poststall of 12 Novel Planform Shapes
- Gatlin, Gregory M.; NASA Langley Research Center, USA Neuhart, Dan H.; Lockheed Engineering and Sciences Co., USA;
- Mar. 1996; 130p; In English
- Contract(s)/Grant(s): RTOP 505-68-70-04
- Report Nos(s): NASA-TM-4663; NAS 1.15:4663; L-17418; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche


- To determine the flow field characteristics of 12 planform geometries, a flow visualization investigation was conducted in the Langley 16- by 24-Inch Water Tunnel. Concepts studied included flat plate representations of diamond wings, twin bodies, double wings, cutout wing configurations, and serrated forebodies. The off-surface flow patterns were identified by injecting colored dyes from the model surface into the free-stream flow. These dyes generally were injected so that the localized vortical flow patterns were visualized. Photographs were obtained for angles of attack ranging from 10° to 50°, and all investigations were conducted at a test section speed of 0.25 ft per sec. Results from the investigation indicate that the formation of strong vortices on highly swept forebodies can improve poststall characteristics; however, the asymmetric bursting of these vortices could produce substantial control problems. A wing cutout was found to significantly alter the position of the forebody vortex on the wing by shifting the vortex inboard. Serrated forebodies were found to effectively generate multiple vortices over the configuration. Vortices from 65° swept forebody serrations tended to roll together, while vortices from 40° swept serrations were more effective in generating additional lift caused by their more independent nature.


- Author
- *Water Tunnel Tests; Flow Visualization; Flow Distribution; Free Flow; Planforms; Wing Profiles; Aerodynamic Configurations*


## Key

1. Document ID Number, Corporate Source
2. Title
3. Author(s) and Affiliation(s)
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# AERONAUTICAL ENGINEERING

*A Continuing Bibliography (Suppl. 390)*

DECEMBER 25, 1998


## 01
## AERONAUTICS

19980237782 Air Force Research Lab., Materials and Manufacturing Directorate, Wright-Patterson AFB, OH USA
*Proceedings of the 1997 USAF Aircraft Structural Integrity Program Conference, Volume 2. Final Report, 2-4 Dec. 1997*
Waggoner, Gary K.; Lincoln, John W.; Rudd, James L.; Aug. 1998; 570p; In English; USAF Aircraft Structural Integrity Program Conference, 24 Dec. 1997, San Antonio, TX, USA
Contracts/Grants(s): Proj. 4349
Report No.(s): AD-A353945; AFRL-ML-WP-TR-1998-4134-VOL-2; No Copyright; Avail: CASI; A24, Hardcopy; A04, Microfiche

This report contains the proceedings of the 1997 USAF Structural Integrity Program Conference held at the Hyatt Regency Hotel in San Antonio, Texas, from 24 December 1997. The conference, which was sponsored by the Aeronautical Systems Center's Engineering Directorate and the Air Force Research Laboratory's Air Vehicles and Materials and Manufacturing Directorates, was hosted by the San Antonio Air Logistics Center Aircraft Directorate, Aircraft Structural Integrity Branch (SA-ALC/LADD). This conference, as in previous years, was held to permit experts in the field of structural integrity to communicate with each other and to exchange views on how to improve the structural integrity of military weapon systems. Sessions were primarily focused on analysis and testing, engine structural integrity, structural materials and inspections, structural repair, and force management. This year, as in previous years, our friends from outside the US borders provided the audience with outstanding presentations on activities within their countries. It is anticipated this conference will include their contributions in the agenda of future meetings.
DTIC
*Conferences; Aircraft Structures; Systems Engineering; Aeronautical Engineering*

19980237783 Air Force Research Lab., Materials and Manufacturing Directorate, Wright-Patterson AFB, OH USA
*Proceedings of the 1997 USAF Aircraft Structural Integrity Program Conference, volume 1, ASIP. Final Report, 2-4 Dec. 1997*
Waggoner, Gary K.; Lincoln, John W.; Rudd, James L.; Aug. 1998; 568p; In English; USAF Aircraft Structural Integrity Program Conference, 24 Dec. 1997, San Antonio, TX, USA; Sponsored by San Antonio Air Logistics Center, USA
Contracts/Grants(s): Proj. 4349
Report No.(s): AD-A353944; AFRL-ML-WP-TR-1998-4134-VOL-1; No Copyright; Avail: CASI; A24, Hardcopy; A04, Microfiche

This report contains the proceedings of the 1997 USAF Structural Integrity Program Conference held at the Hyatt Regency Hotel in San Antonio, Texas, from 24 December 1997. The conference, which was sponsored by the Aeronautical System Center's Engineering Directorate and the Air Force Research Laboratory's Air Vehicles and Materials and Manufacturing Directorates, was hosted by the San Antonio Air Logistics Center Aircraft Directorate, Aircraft Structural Integrity Branch (SA-ALC/LADD). This conference, as in previous years, was held to permit experts in the field of structural integrity to communicate with each other and to exchange views on how to improve the structural integrity of military weapon systems. Sessions were primarily focused on analysis and testing, engine structural integrity, structural materials and inspections, structural repair, and force management. This year, as in previous years, our friends from outside the US borders provided the audience with outstanding presentations on activities within their countries. It is anticipated this conference will include their contributions in the agenda of future meetings.
DTIC
*Conferences; Aircraft Structures; Systems Engineering; Composite Materials*

# 02
# AERODYNAMICS

*Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces, and internal flow in ducts and turbomachinery*

19980137091 NASA Langley Research Center, Hampton, VA USA

Free-Spinning Tunnel Investigation of a 1/25-Scale Model of the Chance Vought F8U-1P Airplane

**Bowman, James S., Jr.**, NASA Langley Research Center, USA; **Healy, Frederick M.**, NASA Langley Research Center, USA; Sep 28, 1959; 28p; In English

Report No(s): NASA-TM-SX-196; L-714; NASA-AD-3137; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An investigation has been made in the Langley 20-foot free-spinning tunnel on a 1/25-scale dynamic model to determine the spin and recovery characteristics of the Chance Vought F8U-1P airplane. Results indicated that the F8U-1P airplane would have spin recovery characteristics similar to the XF8U-1 design, a model of which was tested and the results of the tests reported in NACA Research Memorandum SL56L31b. The results indicate that some modification in the design, or some special technique for recovery, is required in order to insure satisfactory recovery from fully developed erect spins. The recommended recovery technique for the F8U-1P will be full rudder reversal and movement of ailerons full with the spin (stick right in a right spin) with full deflection of the wing leading-edge flap. Inverted spins will be difficult to obtain and any inverted spin obtained should be readily terminated by full rudder reversal to oppose the yawing rotation and neutralization of the longitudinal and lateral controls. In an emergency, the same size parachute recommended for the XF8U-1 airplane will be adequate for termination of the spin: a stable parachute 17.7 feet in diameter (projected) with a drag coefficient of 1.14 (based on projected diameter) and a towline length of 36.5 feet.

Author

*Aircraft Spin; Spin Dynamics; Wind Tunnel Tests; Scale Models; Flapping; Control Surfaces; Control Stability; Aerodynamic Stalling; Maneuvers*

19980237127 ESDU International Ltd., London, UK

VGK Method for Two-Dimensional Aerofoil Sections, Part 3, Estimation of Separation Boundary in Transonic Flow

Oct 1997; 24p; In English; Included in the Transonic Aerodynamics Sub-series

Report No(s): ESDU-97030/PT3; No Copyright; Avail: Issuing Activity (ESDU International, 27 Corsham St., London, N1 6UA, England); Hardcopy, Microfiche

ESDU 97030 describes the use of VGK, which applies only when the boundary layer is attached, to estimate a separation boundary, in terms of lift coefficient and Mach number, using the method of ESDU 81020 which essentially relies on calibrating VGK against experimental data. There the boundary is defined as corresponding to conditions on the upper surface of the aerofoil for which the shock strength and the adverse pressure gradient are sufficiently severe for the trailing-edge pressure coefficient, relative to its trend with increasing lift coefficient or Mach number in attached flow, to have decreased by 0.05. ESDU 81020 derives two criteria, either of which has to be met for a point to lie on that separation boundary. One criterion relates to conditions just ahead of an upper surface shock wave and one to conditions in the upper-surface flow near the trailing edge. The estimation of such a point requires a number of VGK runs, the first being made for conditions where there are significant margins for both criteria. Successive runs are then made at increasing angle of attack until one criterion is close to zero for two successive runs (required to ensure VGK convergence). A FORTRAN program is provided to manage these calculations and provide a record of the flow conditions and criteria margins. Results from example calculations for two aerofoils are given and the estimated separation data fall within the limits of accuracy suggested in ESDU 81020.

Author

*Prediction Analysis Techniques; Two Dimensional Bodies; Computation; Estimating; Applications Programs (Computers); Airfoil Profiles; Aerodynamic Coefficients*

19980237128 ESDU International Ltd., London, UK

Effect of Trailing-Edge Flap Deployment on Average Downwash at the Tailplane at Low Speeds

Sep 1997; 94p; In English; Included in the Aerodynamics Sub-series

Report No(s): ESDU-97021; No Copyright; Avail: Issuing Activity (ESDU International, 27 Corsham St., London, N1 6UA, England); Hardcopy, Microfiche

ESDU 97021 provides a graphical semi-empirical method based on a correlation of calculations made using a trailing horseshoe-vortex model to represent a straight-tapered wing with plain flaps over a range of wing sweeps, taper and aspect ratios, flap chords and spans, tailplane locations and Mach numbers. It was found that the data could be represented by taking values for a datum geometry and Mach number and applying correction factors for departures from that condition. Predictions by the method

were then compared with wind tunnel data drawn from the literature and a further factor was found to be required depending on whether the tailplane was mounted on the body or on the fin. No effects due to flap type were found and the effect of a central flap cut out is accounted for in the lift coefficient used in the method which is that due to flap deployment. For wings that are not straight-tapered the equivalent wing concept of ESDU 76003 may be used. The method applies to fully-attached flow with linear aerodynamic characteristics (an angle of attack range from -3 to 12 degrees is suggested). Overall, the mean downwash angle is predicted to within 15 per cent as shown by a sketch comparing predictions with experimental results. A fully-worked example illustrates the use of the method. ESDU 88020 provides a prediction method for the case with flaps undeployed.

**Author**

*Flapping, Deployment, Downwash, Trailing Edge Flaps, Low Speed, Graeff Calculus, Prediction Analysis Techniques*

19980237129 ESDU International Ltd., London, UK

Slope of Aerofoil Lift Curve for Subsonic Two-Dimensional Flow

Sep. 1997; 21p. In English. Supersedes ESDU-Aero-W.01.01.05. Included in the Aerodynamics Sub-series

Report No.(s): ESDU-97020; ESDU-Aero-W.01.01.05; No Copyright. Avail: Issuing Activity (ESDU International, 27 Corsham St., London, N1 6UA, England); Hardcopy, Microfiche

ESDU 97020 gives a method for predicting the linear viscous lift-curve slope of symmetric and cambered aerofoils in subcritical compressible flow. The VGK program (see ESDU 96028 and 96029 in the Transonic Aerodynamics Sub-series) was applied to a range of NACA aerofoils and also to aerofoils with complex camber lines to derive graphs of a reduction factor to be applied to the inviscid lift-curve slope from ESDU 76024. Investigation of the effect of aerofoil geometry on lift-curve slope showed that geometry effects on the reduction factor could be adequately characterized by the use of an equivalent trailing-edge angle based on thickness at 0.9 and 0.99 of chord for the symmetric aerofoils, with the additional requirement of a trailing-edge upper surface angle based on ordinates at the same positions for the cambered aerofoils. The method also requires the assumption of transition positions on the upper and lower surfaces, and the Reynolds and Mach numbers. It applies for fully-attached boundary layers but becomes unreliable if lift-curve slope is strongly dependent on transition movement with angle of attack. It predicts the reduction factor to within 0.005. A fully worked example illustrates the use of the method and the aerofoils used in its derivation are listed.

**Author**

*Subsonic Flow, Two-Dimensional Flow, Slopes, Airfoils, Procedures, Predictions, Boundary Layers*

19980237132 ESDU International Ltd., London, UK

Guide to Wing Aerodynamic Design

Aug. 1997; 65p. In English. Included in the Transonic Aerodynamics Sub-series

Report No.(s): ESDU-97017; No Copyright. Avail: Issuing Activity (ESDU International, 27 Corsham St., London, N1 6UA, England); Hardcopy, Microfiche

ESDU 97017 describes the aerodynamic design of swept wings intended primarily for transonic flow; it is concerned with the application of Computational Fluid Dynamics (CFD) but not with the choice of particular software. The process is applicable to all wings but is described in terms of conventional trapezoidal planforms. The various steps in the design process are considered in turn as they would be in a real design study. It starts with consideration of the definition of aerofoil shape, discusses the desired features of the two- and three-dimensional pressure distributions, and explains the benefits of working with surface curvature distribution. The need to maintain a smooth profile for CFD work is emphasised. Application of inverse and optimum design techniques is briefly considered and the implications of viscous effects are introduced. Structural and geometric aspects in determining the jig and flying shapes of the wing are discussed. The modification of the wing design to account for interference due to the effects of fuselage, tip tanks or stores and pylons are discussed and the changes to the pressure distribution illustrated. The specification and use of wind-tunnel models and tests are discussed. The use of flow control devices such as stall strips, fences and vortex generators is explained with a brief consideration of their advantages and limitations. Two tables set out a step-by-step guide to the design process and the one-dimensional isentropic flow relations are listed.

**Author**

*Aerodynamics, Aircraft Design, Swept Wings, Transonic Flow, Fuselages, Optimization, Viscous Flow, Procedures, Design Analysis*

19980237133 ESDU International Ltd., London, UK

Estimation of Airframe Drag by Summation of Components: Principles and Examples

Sep. 1997; 35p. In English. Included in the Aircraft Performance Sub-series

Report No.(s): ESDU-97016; No Copyright. Avail: Issuing Activity (ESDU International, 27 Corsham St., London, N1 6UA, England); Hardcopy, Microfiche

ESDU 97016 summarises several drag estimation methods as illustrative examples of the range of techniques and the levels of sophistication that exist. The methods rely on the summation of contributions due to particular airframe components or flow mechanisms. The discussion includes consideration of datum conditions, the use of simple sweep rules and strip theory in calculating wing profile drag, a brief consideration of excrescence, interference and propulsion systems contributions, and the treatment of trailing vortex, wave and longitudinal trim drag. Those contributions that should, ideally, be considered are itemised in a Reference Scheme that sets the format and notation for a group of tables that provide the illustrative examples. These examples range from the relatively simple to those that require at least some usage of Computational Fluid Dynamics techniques. A table lists all ESDU documents that can be used to estimate the drag components. ESDU 81026 considers the representation of airframe drag for performance calculations and gives detailed examples of individual aircraft drag characteristics.

Author

*Estimating, Airframes, Aerodynamic Drag, Procedures, Drag Measurement, Computational Fluid Dynamics*

19980237135 NASA Langley Research Center, Hampton, VA USA

Recent Dynamic Measurements and Considerations for Aerodynamic Modeling of Fighter Airplane Configurations

Brandon, Jay M., NASA Langley Research Center, USA; Foster, John V., NASA Langley Research Center, USA. 1998. 17p. In English. Atmospheric Flight Mechanics, 10-12 Aug. 1998, Boston, MA, USA. Sponsored by American Inst. of Aeronautics and Astronautics, USA

Report No.(s): AIAA Paper 98-4447; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

As airplane designs have trended toward the expansion of flight envelopes into the high angle of attack and high angular rate regimes, concerns regarding modeling the complex unsteady aerodynamics for simulation have arisen. Most current modeling methods still rely on traditional body axis damping coefficients that are measured using techniques which were intended for relatively benign flight conditions. This paper presents recent wind tunnel results obtained, during large-amplitude pitch, roll and yaw testing of several fighter airplane configurations. A review of the similitude requirements for applying sub-scale test results to full-scale conditions is presented. Data is then shown to be a strong function of Strouhal number - both the traditional damping terms, but also the associated static stability terms. Additionally, large effects of sideslip are seen in the damping parameter that should be included in simulation math models. Finally, an example of the inclusion of frequency effects on the data in a simulation is shown.

Author

*Aerodynamic Characteristics, Aerospace Engineering, Aerospace Systems, Mathematical Models, Flight Envelopes, Fighter Aircraft, Angle of Attack, Angular Velocity*

19980237137 NASA Langley Research Center, Hampton, VA USA

A Piloted Simulation Study of Wake Turbulence on Final Approach

Stewart, Eric C., NASA Langley Research Center, USA. 1998. 16p. In English. Atmospheric Flight Mechanics, 10-12 Aug. 1998, Boston, MA, USA. Sponsored by American Inst. of Aeronautics and Astronautics, USA

Report No.(s): AIAA Paper 98-4339; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

A piloted simulation study has been conducted in a research simulator to provide a means to estimate the effects of different levels of wake turbulence on final approach. A worst-case methodology was used to ensure conservative estimates. Fourteen airline pilots voluntarily participated in the study and flew almost 1000 approaches. The pilots rated the subjective severity of the disturbances using a special rating scale developed for this study. Several objective measures of the airplane/pilot response to the simulated wake turbulence were also made. All the data showed a large amount of variation between pilots and to a lesser extent for a given pilot. Therefore, the data were presented at 50, 70, 90 percentile levels as a function of vortex strength. The data allow estimates of the vortex strength for a given subjective or objective response and vice versa. The results of this study appear to be more conservative than the results of previous studies.

Author

*Airline Operations, Turbulence, Wakes, Vortices, Air Traffic, Air Transportation*

19980237252 Minnesota Univ., Dept. of Aerospace Engineering and Mechanics, Minneapolis, MN USA

*Parallel Three-Dimensional Computation of Fluid Dynamics and Fluid-Structure Interactions of Ram-Air Parachutes Final Report*

Tezduyar, Tayfun E., Minnesota Univ., USA. Sep. 17, 1998. 28p. In English

Contract(s)/Grant(s): NAG9-919; No Copyright; Avail: CASI, A03, Hardcopy; A01, Microfiche

This is a final report as far as our work at University of Minnesota is concerned. The report describes our research progress and accomplishments in development of high performance computing methods and tools for 3D finite element computation of

aerodynamic characteristics and fluid-structure interactions (FSI) arising in airdrop systems, namely ram-air parachutes and round parachutes. This class of simulations involves complex geometries, flexible structural components, deforming fluid domains, and unsteady flow patterns. The key components of our simulation toolkit are a stabilized finite element flow solver, a nonlinear structural dynamics solver, an automatic mesh moving scheme, and an interface between the fluid and structural solvers; all of these have been developed within a parallel message-passing paradigm.

Author

*Dynamic Structural Analysis; Aerodynamic Characteristics; Fluid Dynamics; Structural Design; Unsteady Flow; Parachutes; Computational Fluid Dynamics*

19980237325 ESDU International Ltd., London, UK

Fuselage Interference Effects on Flap Characteristics

Mar. 1997; 9p; In English; Supersedes in part ESDU-75013; Included in the Aerodynamics Sub-series

Report No.(s): ESDU-97003; ESDU-75013; No Copyright; Avail: Issuing Activity (ESDU International, 27 Corsham Street, London, N1 6UA, England); Hardcopy; Microfiche

ESDU 97003 provides an empirical method to allow for the fuselage interference effects on the lift, pitching moment and drag coefficient increments predicted for the isolated wing due to deflection of part-span trailing-edge flaps with central cut-out corresponding to the fuselage width. The methods in the Sub-series for estimating those increments give predictions for full-span flaps that are then factored to account for flaps that do not extend from the tip to the centreline. These factors, which differ with flap type, depend primarily on the inboard and outboard limits of the flap panel and, to a lesser extent, on the wing geometry or spanwise loading. to account for fuselage interference, the flap is extended inboard by a fictitious amount and the part-span factors are evaluated for the new spanwise extent. There was considerable scatter in the data but definite trends were exhibited with variation of wing height. The interference effects were predicted to within 0.04 for lift and pitching moment coefficients, and within 0.005 for drag coefficient. The method applies for flaps that, when deflected, fit closely to the fuselage sides. If the minimum gap between the deflected flap and the fuselage exceeds 5 per cent of the wing semi-span, interference will be negligible.

Author

*Numerical Analysis; Fuselages; Trailing Edge Flaps; Pitching Moments; Aerodynamic Drag*

19980237830 Georgia Inst. of Tech., School of Aerospace Engineering, Atlanta, GA USA

Low Speed Aerodynamics of the X-38 CRV *Final Report, May 1997 - Apr. 1998*

Komerath, N. M., Georgia Inst. of Tech., USA; Funk, R., Georgia Inst. of Tech., USA; Ames, R. G., Georgia Inst. of Tech., USA; Mahalingam, R., Georgia Inst. of Tech., USA; Matos, C., Georgia Inst. of Tech., USA; Jun. 1998; 16p; In English

Cont. act(s)/Grant(s): NAG9-927

Report No.(s): NASA/CR-1998-208344; NAS 1.26:208344; GITAER-EAG-98-03; E16-N63; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This project was performed in support of the engineering development of the NASA X-38 Crew Return Vehicle system. Wind tunnel experiments were used to visualize various aerodynamic phenomena encountered by the Crew Return Vehicle (CRV) during the final stages of descent and landing. Scale models of the CRV were used to visualize vortex structures above and below the vehicle, and in its wake, and to quantify their trajectories. The effect of flaperon deflection on these structures was studied. The structure and dynamics of the CRV's wake during the drag parachute deployment stage were measured. Regions of high vorticity were identified using surveys conducted in several planes using a vortex meter. Periodic shedding of the vortex sheets from the sides of the CRV was observed using laser sheet videography as the CRV reached high angles of attack during the quasi-steady pitch-up prior to parafoil deployment. Using spectral analysis of hot-film anemometer data, the Strouhal number of these wake fluctuations was found to be 0.14 based on the model span. Phenomena encountered in flight test during parafoil operation were captured in scale-model tests, and a video photogrammetry technique was implemented to obtain parafoil surface shapes during flight in the tunnel. Forces on the parafoil were resolved using tension gages on individual lines. The temporal evolution of the phenomenon of leading edge collapse was captured. Laser velocimetry was used to demonstrate measurement of the porosity of the parafoil surface. From these measurements, several physical explanations have been developed for phenomena observed at various stages of the X-38 development program. Quantitative measurement capabilities have also been demonstrated for continued refinement of the aerodynamic technologies employed in the X-38 project.

Derived from text

*Aerodynamic Characteristics; Wind Tunnel Tests; Strouhal Number; Vortices; X-38 Crew Return Vehicle; Aircraft Wakes; Vortex Shedding; Parafoils; Flow Visualization*

19980237568 Lockheed Martin Tactical Aircraft Systems, Fort Worth, TX USA

Analysis of Limit Cycle Oscillation/Transonic High Alpha Flow Visualization, Part I, Discussion *Final Report, Oct. 1994 - Oct. 1997*

Cunningham, Atlee M., Jr., Lockheed Martin Tactical Aircraft Systems, USA; Geurts, Evert G., Lockheed Martin Tactical Aircraft Systems, USA; Jan. 1998; 98p; In English

Contract(s)/Grant(s): F49620-94-C-0093; AF Proj. 2401

Report No.(s): AD-A353044; AFRL-VA-WP-TR-1998-3003; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

A flow visualization test was conducted with the simple straked wing in August, 1996 (at the National Aerospace Laboratory NLR, The Netherlands), for the purpose of obtaining flow visualization data to complement the pressure and force data base generated in earlier tests of the same configuration. This test was conducted in two parts to examine the flow field characteristics: (1) at high alpha conditions that involve vortices, shocks, and separated flows, and (2) at low alpha conditions typical of transonic LCO flows with and without tip stores. Laser light sheet/water vapor techniques were used to illuminate the flows, and video recording was used to obtain the data. Both low and high speed video cameras were used to examine spanwise and streamwise laser sheet positions. In addition, under NLR funding, some preliminary particle image velocimetry (PIV) data were obtained at M= 0.225 and 0.6, as well as some pulsed laser flow visualization (9 nano-sec pulse) at M=0.9. Correlation was performed between the flow visualization data from this test and the pressure/force data obtained in 1992 on the same configuration.

DTIC

*Flow Visualization; Transonic Flow; Oscillations; Performance Tests; Data Acquisition*

19980237872 Air Force Flight Test Center, Edwards AFB, CA USA

A Limited Evaluation of the Have Derivatives Process to Reduce Aircraft Stability Derivative Estimate Errors Caused by Turbulence (HAVE DERIVATIVES) *Final Report, 15 Sep - 7 Oct. 1997*

Hoffman, Lawrence M.; Hagan, Joel J.; Verburg, Cornelis A.; Eshel, guy; LEbraly, Hubert; May 1998; 96p; In English

Report No.(s): AD-A354309; AFFTC-TR-97-45; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

This report presents the results of a limited evaluation of the HAVE DERIVATIVES data reduction process in reducing aircraft stability derivative estimate errors caused by turbulence. The evaluation consisted of 11 sorties totaling 15.2 flight hours. The sorties were flown at the Air Force Flight Test Center, Edwards AFB, California, in a production-representative Block 15 F-16B aircraft. The three specific objectives for this project were to establish a basis data set of results against which to compare the results of the subsequent tests; compare stability derivative estimate results found using the HAVE DERIVATIVES process with Personal Computer Parameter Identification (PCPID), on calm air data, to the basis data set results established in objective 1; and compare stability derivative estimate results found using PCPID alone and the HAVE DERIVATIVES process with PCPID, on turbulent air data, to the basis data set results established in objective 1, and to each other.

DTIC

*Aircraft Stability; Turbulence; Error Analysis; Data Reduction; Stability Derivatives; Flight Tests*

## 03
## AIR TRANSPORTATION AND SAFETY

*Includes passenger and cargo air transport operations; and aircraft accidents.*

19980237029 NASA Ames Research Center, Moffett Field, CA USA

Human Factors Assessment: The Passive Final Approach Spacing Tool (pFAST) Operational Evaluation

Lee, Katharine K.; NASA Ames Research Center, USA; Sanford, Beverly D.; Sterling Software, Inc., USA; Oct. 1998; 44p; In English

Contract(s)/Grant(s): RTOP 538-18-24

Report No.(s): NASA/TM-1998-208750; NAS 1.15:208750; A-9900077; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Automation to assist air traffic controllers in the current terminal and en route air traffic environments is being developed at Ames Research Center in conjunction with the Federal Aviation Administration. This automation, known collectively as the Center-TRACON Automation System (CTAS), provides decision- making assistance to air traffic controllers through computer-generated advisories. One of the CTAS tools developed specifically to assist terminal area air traffic controllers is the Passive Final Approach Spacing Tool (pFAST). An operational evaluation of PFAST was conducted at the Dallas/Ft. Worth, Texas, Terminal Radar Approach Control (TRACON) facility. Human factors data collected during the test describe the impact of the automation upon the air traffic controller in terms of perceived workload and acceptance. Results showed that controller self-reported work-

load was not significantly increased or reduced by the PFAST automation; rather, controllers reported that the levels of workload remained primarily the same. Controller coordination and communication data were analyzed, and significant differences in the nature of controller coordination were found. Controller acceptance ratings indicated that PFAST was acceptable. This report describes the human factors data and results from the 1996 Operational Field Evaluation of Passive TAST.
Author
*Air Traffic Controllers (Personnel); Human Factors Engineering; Radar Approach Control; Workloads (Psychophysiology)*

19980237722 Naval War Coll., Newport, RI USA
Civil Reserve Air Fleet Stage III: Viability and Implications *Final Report*
Draper, Mark W.; Jun. 19, 1998; 31p; In English
Report No.(s): AD-A351755; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Civil Reserve Air Fleet (CRAF) is a vital component of the nation's strategic airlift capability. Stage III is the most aggressive CRAF activation level, contributing heavily to wartime lift needs but also withdrawing the greatest amount of capacity from commercial service. This paper explores the thesis that Stage III is not a viable policy option, and examines the impact such a conclusion would have on our two major theater war (MTW) strategy. Section One analyzes the viability of activating Stage III with respect to feasibility ("Could it be done?") and acceptability ("Would it be done?"). To assess the economic and political costs of activation, this section focuses on how much residual air carrier capacity would be left in the private sector after Stage III activation and mobilization of aircrews with reserve component obligations. Section Two examines the affect the absence of Stage III would have on our two MTW strategy. Finally, Section Three puts forth conclusions and makes recommendations to improve the realism of the assumptions that underlie US contingency and airlift modernization plans. The paper concludes that the economic and political costs of implementing Stage III make the assumption of activation an unsound basis for contingency planning. Also, the absence of Stage III lift capacity would seriously degrade our two MTW strategy, elevating risk in the halting phase of the second MTW and ceding operational initiative to the enemy for a longer period. Recommendations include a call for airline industry executives and senior government officials to reduce Stage III to a level that could be reliably activated in time of crisis. On the basis of this new, smaller Stage III, contingency and airlift modernization plans merit revision.
DTIC
*Air Transportation; Viability; Civil Aviation*

19980237775 Natal Univ., Dept. of Mechanical Engineering, Durban, South Africa
Proceedings Second International Conference
Adall, S., Editor, Natal Univ., South Africa; Morozov, E. V., Editor, Natal Univ., South Africa; Verijenko, V. E., Editor, Natal Univ., South Africa; Jun. 1998; 570p; In English; Composite Science and Technology, 9-11 Jun. 1998, Durban, South Africa
Contract(s)/Grant(s): N68171-98-M-5331
Report No.(s): AD-A353971; No Copyright; Avail: CASI; A24, Hardcopy; A04, Microfiche

The design and development of supersonic/hypersonic flight vehicles, of Future reusable space transportation systems, launch vehicles and of advanced propulsion systems constitute challanging issues for the aeronautical engineers and the research workers insolved in these problems. It is a well-known fact that during their flight missions, the structure of flight vehicles has to with stand severe aerodynamic, aeroacoustic and thermomechanical loads. The temperatures involved are likely to range from the extreme lows of cryogenic fuels and radiation to space, to the highs associated with aerodynamic heating, heat from propulsion unit and radiation from the sun. In spite of the increased flexibility which is likely to characterize the structure of these flight vehicles, they have to be able to fulfill a multitude of missions in complex environmental conditions and feature an expanded operational envelope. The same is valid with the reusable space vehicles, which, for evident reasons, require a prolongation of their operational life, without impairing upon the security of flight.
DTIC
*Supersonic Flight; Hypersonic Flow; Design Analysis; Product Development; Propulsion System Performance; Conferences; Reusable Spacecraft*

19980237886 Air Force Inst. of Tech., School of Logistics and Acquisition Management, Wright-Patterson AFB, OH USA
Air Refueling Operations in the North Pacific: Is There a More Efficient Method?
Rauenhorst, Michael J.; Jun. 1998; 134p; In English
Report No.(s): AD-A354268; AFIT/GMO/LAS/98J-15; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The 1997 Air Force Long Range Plan states the Air Force will continue to rely on the Air Reserve Component (ARC) in an integrated Total Force. Driven by the desire to maximize efficiency and operational effectiveness within allocated resources, the Air Force will continue to look for new opportunities, to include examining ARC involvement in new mission areas and optimiz-

ing the reverse associate unit. The best location to attempt either a KC-135 reverse associate unit or a non-traditional Air National Guard KC-135 squadron might be in the North Pacific Theater. Both options would help reduce the operations tempo of KC-135 squadrons, might help with aircrew retention, and would increase the reliability and cost effectiveness of air refueling operations in the North Pacific. This paper performs a cost benefit analysis on several proposals to satisfy the air refueling requirements in the North Pacific in a more cost efficient manner than today's current operations. Results of this study reflect an overall cost savings and more efficient use of air refueling resources with an increase in the number of KC-135Rs assigned to or associated with the 168th Air Refueling Wing. This paper examined several basing options and the associated costs and benefits.
DTIC
*Air to Air Refueling; System Effectiveness; Costs; Cost Analysis*

## 04
## AIRCRAFT COMMUNICATIONS AND NAVIGATION

*Includes digital and voice communication with aircraft, air navigation systems (satellite and ground based), and air traffic control.*

19980237248 NASA Goddard Space Flight Center, Greenbelt, MD USA
Spaceborne GPS: Current Status and Future Visions
Bauer, Frank H., NASA Goddard Space Flight Center, USA; Hartman, Kate, NASA Goddard Space Flight Center, USA; Lightsey, E. Glenn, NASA Goddard Space Flight Center, USA; 1998; 13p; In English; Aerospace, 21-28 Mar. 1998; Sponsored by Institute of Electrical and Electronics Engineers, USA; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Global Positioning System (GPS), developed by the Department of Defense, is quickly revolutionizing the architecture of future spacecraft and spacecraft systems. Significant savings in spacecraft life cycle cost, in power, and in mass can be realized by exploiting Global Positioning System (GPS) technology in spaceborne vehicles. These savings are realized because GPS is a systems sensor-it combines the ability to sense space vehicle trajectory, attitude, time, and relative ranging between vehicles into one package. As a result, a reduced spacecraft sensor complement can be employed on spacecraft and significant reductions in space vehicle operations cost can be realized through enhanced on- board autonomy. This paper provides an overview of the current status of spaceborne GPS, a description of spaceborne GPS receivers available now and in the near future, a description of the 1997-1999 GPS flight experiments and the spaceborne GPS team's vision for the future.
Author
*Spacecraft Instruments; Global Positioning System; Autonomy; Space Flight*

19980237445 Maritime Administration, Office of Labor, Traning and Safety, Washington, DC USA
Vessel Piloting Cooperative Program's Portable Electronic Piloting Aid Project. Summary Report *Final Report*
Kirby, V., Maritime Administration, USA; Apr. 1998; 153p; In English
Report No.(s): PB98-177934; MA-RD-250-98000; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

This report describes the activity and findings of the Vessel Piloting Cooperative's Evaluation Project of Portable Electronic Piloting Aid (PEPA) systems for ship pilots. Technological developments in the field of navigational technology, including electronic charting and Differential Global Positioning Systems (DGPS), have made possible the manufacture of highly accurate, carry-aboard navigational computers designed specifically for use by ship pilots. Over a two year period, the Piloting Cooperative's forum, the APA Navigation and Technology Committee, with the assistance of the Volpe National Transportation Systems Center and the US Maritime Administration, conducted a multi-step project designed to investigate this technology and its utility for the practice of piloting. The study team: solicited participation from all known and interested PEPA manufacturers; encouraged the development of prototype units for a set of test ports throughout the country; monitored the implementation of the most promising systems in the test ports; and conducted trials and evaluation of the equipment through survey and personal assessment by working pilots.
NTIS
*Ships; [illegible]rs; Navigation Aids; Pilots (Personnel)*

19980[illegible]455 NASA Goddard Space Flight Center, Greenbelt, MD USA
Vector Observation-Aided/Attitude-Rate Estimation Using Global Positioning System Signals
Oshman, Yaakov, National Academy of Sciences - National Research Council, USA; Markley, F. Landis, NASA Goddard Space Flight Center, USA; IEEE Journal of Aerospace and Electronic Systems; 1997; 34p; In English; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A sequential filtering algorithm is presented for attitude and attitude-rate estimation from Global Positioning System (GPS) differential carrier phase measurements. A third-order, minimal-parameter method for solving the attitude matrix kinematic equation is used to parameterize the filter's state, which renders the resulting estimator computationally efficient. Borrowing from tracking theory concepts, the angular acceleration is modeled as an exponentially autocorrelated stochastic process, thus avoiding the use of the uncertain spacecraft dynamic model. The new formulation facilitates the use of aiding vector observations in a unified filtering algorithm, which can enhance the method's robustness and accuracy. Numerical examples are used to demonstrate the performance of the method.

Author

*Dynamic Models; Global Positioning System; Kinematic Equations; Parameterization; Robustness (Mathematics); Spacecraft Models; Statistical Analysis*

19980237474 Colorado Univ., Colorado Springs, CO USA

Integration of the Global Positioning System with an Inertial Navigation System

Marvel, Derek, Colorado Univ., USA; May 11, 1998; 37p; In English

Report No.(s): AD-A353869; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Navigation is the determination of the position and velocity of a moving vehicle. Navigation systems used to measure this state vector can be one of two types, either positioning or dead-reckoning. Positioning systems, such as the Global Positioning System (GPS) measure the state vector without regard to the path traveled by the vehicle in the past. On the other hand, dead-reckoning navigation systems, such as the Inertial Navigation System (INS) determine the state vector from a continuous series of measurements relative to an initial position, by integrating the unique and complementary characteristics of each system into one integrated INS/GPS system, accuracies as well as additional benefits can be achieved even though unattainable by either system independently. The optimal method of integrating these two systems is through the use of a Kalman filter. This mathematical technique is used for computing the best estimate of the state of a process which varies with time. Approaches to this filtering can either be centralized in a main filter or federated, where filtering is done at individual sensors. This theory can then be applied to real world scenarios, whether it be an aircraft during flight, an aircraft during precision approach landings, or the failure detection and isolation of a GPS signal.

DTIC

*Global Positioning System; Inertial Navigation; Detection; Navigation*

19980237542 Scripps Institution of Oceanography, Institute of Geophysics and Planetary Physics, La Jolla, CA USA

Permanent GPS Geodetic Array in Southern California *Final Report*

Green, Cecil H., Scripps Institution of Oceanography, USA; Green, Ida M., Scripps Institution of Oceanography, USA; 1998; 7p; In English

Contract(s)/Grant(s): NAG5-1917; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

The southern California Permanent GPS Geodetic Array (PGGA) was established in the spring of 1990 to evaluate continuous Global Positioning System (GPS) measurements as a new tool for monitoring crustal deformation. Southern California is an ideal location because of the relatively high rate of tectonic deformation, the high probability of intense seismicity, the long history of conventional and space geodetic measurements, and the availability of a well developed infrastructure to support continuous operations. Within several months of the start of regular operations, the PGGA recorded far-field coseismic displacements induced by the June 28, 1992 (M(sub w)=7.3), Landers earthquake, the largest magnitude earthquake in California in the past 40 years and the first one to be recorded by a continuous GPS array. Only nineteen months later, on 17 January 1994, the PGGA recorded coseismic displacements for the strongest earthquake to strike the Los Angeles basin in two decades, the (M(sub e)=6.7) Northridge earthquake. At the time of the Landers earthquake, only seven continuous GPS sites were operating in southern California; by the beginning of 1994, three more sites had been added to the array. However, only a pair of sites were situated in the Los Angeles basin. The destruction caused by the Northridge earthquake spurred a fourfold increase in the number of continuous GPS sites in southern California within 2 years of this event. The PGGA is now the regional component of the Southern California Integrated GPS Network (SCIGN), a major ongoing densification of continuous GPS sites, with a concentration in the Los Angeles metropolitan region. Continuous GPS provides temporally dense measurements of surface displacements induced by crustal deformation processes including interseismic, coseismic, postseismic, and aseismic deformation and the potential for detecting anomalous events such as preseismic deformation and interseismic strain variations. Although strain meters yield much higher short-term resolution to a period of about 1 year, a single continuous GPS site is significantly less expensive than a single strain meter and probably has better long-term stability beyond a 1-year period. Compared to less frequent field measurements,

continuous GPS provide the means to better characterize the errors in GPS position measurements and thereby obtain more realistic estimates of derived parameters such as site velocities.
Derived from text
*Geodetic Surveys; Global Positioning System; Crustal Fractures; Seismology; Tectonics*

19980237566 NASA Goddard Space Flight Center, Greenbelt, MD USA
A Novel Sensor for Attitude Determination Using Global Positioning System Signals
Crassidis, John L., Catholic Univ. of America, USA; Quinn, David A., NASA Goddard Space Flight Center, USA; Markley, F. Landis, NASA Goddard Space Flight Center, USA; McCullough, Jon D., NASA Goddard Space Flight Center, USA; 1998; 27p; In English; Navigation and Control Conference, 10-12 Aug. 1998, Boston, MA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An entirely new sensor approach for attitude determination using Global Positioning System (GPS) signals is developed. The concept involves the use of multiple GPS antenna elements arrayed on a single sensor head to provide maximum GPS space vehicle availability. A number of sensor element configurations are discussed. In addition to the navigation function, the array is used to find which GPS space vehicles are within the field-of-view of each antenna element. Attitude determination is performed by considering the sightline vectors of the found GPS space vehicles together with the fixed boresight vectors of the individual antenna elements. This approach has clear advantages over the standard differential carrier-phase approach. First, errors induced by multipath effects can be significantly reduced or eliminated altogether. Also, integer ambiguity resolution is not required, nor do line biases need to be determined through costly and cumbersome self-surveys. Furthermore, the new sensor does not require individual antennas to be physically separated to form interferometric baselines to determine attitude. Finally, development potential of the new sensor is limited only by antenna and receiver technology development unlike the physical limitations of the current interferometric attitude determination scheme. Simulation results indicate that accuracies of about 1 degree (3 omega) are possible.
Author
*Global Positioning System; Antenna Components; Attitude (Inclination); Boresights; Field of View; Multipath Transmission; Interferometry*

19980237778 Civil Aeromedical Inst., Oklahoma City, OK USA
An Acoustic Analysis of ATC Communication *Final Report*
Primzo, O. V., Civil Aeromedical Inst., USA; Lieberman, Philip, Brown Univ., USA; Jul. 1998; 27p; In English
Report No.(s): AD-A353962; DOT/FAA/AM-98/20; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Radio communication is the primary means by which pilots and air traffic control specialists (ATCSs) transmit verbal messages between each other. Controllers learn to speak a particular grammar using a pre-defined cadence during their initial training at the FAA Academy and at their assigned air traffic control facility. In addition to the verbal message transmitted orally, the receiver also receives extralinguistic information conveyed by the speaker. Through additional training and experience, controllers learn to conceal potential emotional content from their speech. while researchers have not yet identified consistently reliable quantifiable factors, several aspects of speech production have been shown to be related to physiological and task-induced stress. DTIC
*Acoustics; Communication Networks; Radio Communication; Verbal Communication; Air Traffic Control*

19980237790 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA
Global Positioning System (GPS) Receiver Design For Multipaths Mitigation
Gadallah, El-Sayed Abdel-Salam; Aug. 1998; 274p; In English
Report No.(s): AD-A353917; AFIT/DS/ENG/98-11; No Copyright; Avail: CASI; A12, Hardcopy; A03, Microfiche

Multipath effects are a source of error degrading the accuracy of DGPS signal processing. The statistical models of multipath are determined by user location and, in addition are time varying. There is no unified statistical model for the multipath signal. Therefore the solution of the multipath problem using statistical models is difficult. This research introduces a new estimator that can detect the presence of multipath, can determine the unknown number of multipath components and can estimate multipath parameters in the GPS receiver (time delay and attenuation coefficients). Furthermore the multipath signal parameters are estimated at any instant of observation. The new estimator is based on maximum likelihood estimation applied to multiple observations of a linear model (regression form) of the received signal. In addition, the estimator is based on a recursive deployment of the multipath time delay. An improvement is achieved to the accuracy of multipath estimates at a low signal-to-noise level by applying Kalman filtering as a cascaded estimator. Kalman filtering application can be considered as an important tool for separating the direct path signal from multipath in noise. This dissertation also includes the design of new modified tracking loops

endowed with the mentioned estimator: a modified Phase Lock Loop (PLL) for carrier tracking and a modified Delay Locked-Loop (DLL) in the code tracking. The modified loops can properly track the received direct signal in the presence of multipaths where the standard tracking loops are disabled. Simulations of the standard and the modified loops are presented. Tracking performance in noise are investigated and a future work is suggested.
DTIC
*Global Positioning System; Receivers; Multipath Transmission; Statistical Analysis; Systems Engineering*

19980237926 Air Force Inst. of Tech., School of Logistics and Acquisition Management, Wright-Patterson AFB, OH USA
An Analysis of Satellites as the Sole Source Precision Approach System
Quinn, Timothy J., Jun. 1998; 60p; In English
Report No.(s): AD-A354278; AFIT/GMO/LAL/98J-14; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

The tremendous growth in the amount of worldwide air traffic has also brought increasing congestion in the skies. Air Traffic Control agencies are attempting to shape policies to alleviate air traffic volume problems in terminal areas using new satellite technologies. This paper examines the current and future regulatory and policy environment for the use of satellites, particularly the Global Positioning System (GPS), as a stand-alone method of precision approaches from three perspectives: the Continental USA (CONUS), the European continent, and the Department of Defense (DoD). Each of these perspectives present unique obstacles in the adoption of satellites as the sole use for precision approaches. Finally, three conclusions are offered regarding the transition to satellites for the precision approach system of the 21st century. First, a truly single source global satellite system (e.g., GPS) probably may never exist, but rather, there will a combination from various governments and agencies. Second, satellite users should consider using systems capable of interrogating signals from more than one satellite source. Finally, air traffic control agencies should maintain a network of backup precision approach systems until the success of a stand-alone satellite system is established.
DTIC
*Air Traffic; Air Traffic Control; Policies; Global Positioning System; Precision; Communication Satellites*

19980237947 NASA Goddard Space Flight Center, Greenbelt, MD USA
Efficient and Optimal Attitude Determination Using Recursive Global Positioning System Signal Operations
Crassidis, John L., Catholic Univ. of America, USA; Lightsey, E. Glenn, NASA Goddard Space Flight Center, USA; Markley, F. Landis, NASA Goddard Space Flight Center, USA; Journal of Guidance, Control and Dynamics; 1998; 32p; In English; Guidance, Navigation and Control, 10-12 Aug. 1998, Boston, MA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

In this paper, a new and efficient algorithm is developed for attitude determination from Global Positioning System signals. The new algorithm is derived from a generalized nonlinear predictive filter for nonlinear systems. This uses a one time-step ahead approach to propagate a simple kinematics model for attitude determination. The advantages of the new algorithm over previously developed methods include: it provides optimal attitudes even for coplanar baseline configurations; it guarantees convergence even for poor initial conditions; it is a non-iterative algorithm; and it is computationally efficient. These advantages clearly make the new algorithm well suited to on-board applications. The performance of the new algorithm is tested on a dynamic hardware simulator. Results indicate that the new algorithm accurately estimates the attitude of a moving vehicle, and provides robust attitude estimates even when other methods, such as a linearized least-squares approach, fail due to poor initial starting conditions.
Author
*Attitude (Inclination); Global Positioning System; Nonlinear Systems; Planar Structures; Algorithms; Nonlinear Filters*

## 05
## AIRCRAFT DESIGN, TESTING AND PERFORMANCE

*Includes aircraft simulation technology*

19980237090 NASA Langley Research Center, Hampton, VA USA
Investigation of Low-Subsonic Flight Characteristics of a Model of a Flat-Bottom Hypersonic Boost-Glide Configuration Having a 78 deg Delta Wing
Paulson, John W., NASA Langley Research Center, USA; Shanks, Robert E., NASA Langley Research Center, USA; Oct. 1959; 34p; In English
Report No.(s): NASA-TM-X-201; L-452; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An investigation of the low-subsonic stability and control characteristics of a model of a flat-bottom hypersonic boost-glide configuration having 78 deg sweep of the leading edge has been made in the Langley full-scale tunnel. The model was flown over an angle-of-attack range from 10 to 35 deg. Static and dynamic force tests were made in the Langley free-flight tunnel. The investigation showed that the longitudinal stability and control characteristics were generally satisfactory with neutral or positive static longitudinal stability. The addition of artificial pitch damping resulted in satisfactory longitudinal characteristics being obtained with large amounts of static instability. The most rearward center-of-gravity position for which sustained flights could be made either with or without pitch damper corresponded to the calculated maneuver point. The lateral stability and control characteristics were satisfactory up to about 15 deg angle of attack. The damping of the Dutch roll oscillation decreased with increasing angle of attack, the oscillation was about neutrally stable at 20 deg angle of attack and unstable at angles of attack of about 25 deg and above. Artificial damping in roll greatly improved the lateral characteristics and resulted in flights being made up to 35 deg angle of attack.

Author

*Boostglide Vehicles; Delta Wings; Longitudinal Stability; Hypersonic Gliders; Flight Characteristics; Static Stability; Swept-back Wings; Wind Tunnel Tests; Aerodynamic Configurations; Lateral Stability*

19980237131 ESDU International Ltd., London, UK

Standard Fatigue Loading Sequences

Jul. 1997; 88p; In English; Included in the Fatigue - Endurance Data Sub-series

Report No.(s): ESDU-97018; No Copyright; Avail: Issuing Activity (ESDU International, 27 Corsham St., London, N1 6UA, England); Hardcopy; Microfiche

ESDU 97018 describes three sequences. TWIST (Transport Wing STandard) represents the stresses in the lower wing skin at the wing root. The derivation is discussed and the flight types and number of cycles used are tabulated. A shortened version is also considered, mini-TWIST. FALSTAFF (Fighter Aircraft Loading STAndard For Fatigue) also represents the stresses in the lower skin at the wing root but for tactical aircraft. Its derivation is discussed, the various missions included described and the method of generating the loading sequence is explained with a flowchart. ENSTAFF (ENvironmental FALSTAFF) was developed for use with composite structures in tactical aircraft and adds to FALSTAFF the effects of moisture and temperature profiles which are tabulated. Helix and Felix represent the loading on hinged and fixed (semi-rigid) rotors. The sortie types, their durations and maneuvers considered are tabulated. Take-off and landing loads are included and the rainflow analyses are presented. Shortened versions are considered.

Author

*Composite Structures; Cycles; Wing Roots; Stress Analysis*

19980237183 Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia

An Investigation of F/A-18 AMAD Gearbox Driveshaft Vibration

Rebbechi, Brian, Defence Science and Technology Organisation, Australia; Burchill, Madeleine, Defence Science and Technology Organisation, Australia; Coco, Gareth, Defence Science and Technology Organisation, Australia; Nov. 1997; 100p; In English

Report No.(s): DSTO-TN-0121; DSTO-AR-010-389; Copyright; Avail: Issuing Activity (DSTO Aeronautical and Maritime Research Lab., PO Box 4331, Melbourne, Victoria 3001, Australia); Hardcopy; Microfiche

The RAAF has experienced several failures of the input bearing of the F/A-18 AMAD (Aircraft Mounted Accessory Drive) gearbox. Two of these failures have resulted in in-flight fires. Measurements of input housing vibration showed very high vibration levels on some aircraft, apparently due to unbalance in the driveshaft assembly. Subsequent measurement of drive-shaft motion confirmed synchronous forward whirl of the driveshaft. The driveshaft system appears to operate below its first critical speed, but there are indications that the first critical speed may not be far above running speed. There is no evidence of significant driveshaft system resonances during the operating speed range of idle to full military power. The unbalance appears to result primarily from clearances in the AMAD gearbox input shaft assembly. These clearances will bring about an initial unbalance of the assembly much greater than specified component tolerances. Partial alleviation of the high vibration has been brought about by rotation of the 19E215-1 driveshaft relative to the input power take-off shaft assembly.

Author

*Examination; A-7 Aircraft; Vibration; Failure; Clearances*

19980237268 NASA Langley Research Center, Hampton, VA USA
Advances in Experiment Design for High Performance Aircraft
Morelli, Eugene A., NASA Langley Research Center, USA; 1998; 17p; In English; System Identification for Integrated Aircraft Development and Flight Testing, 5-7 May 1998, Madrid, Spain; Sponsored by North Atlantic Treaty Organization, Belgium
Report No.(s): Paper 8; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

A general overview and summary of recent advances in experiment design for high performance aircraft is presented, along with results from flight tests. General theoretical background is included, with some discussion of various approaches to maneuver design. Flight test examples from the F-18 High Alpha Research Vehicle (HARV) are used to illustrate applications of the theory. Input forms are compared using Cramer-Rao bounds for the standard errors of estimated model parameters. Directions for future research in experiment design for high performance aircraft are identified.
Author
*F-18 Aircraft; Research Vehicles; Fighter Aircraft; Cramer-Rao Bounds*

19980237337 Sverdrup Technology, Inc., Huntsville, AL USA
X-33 Base Region Thermal Protection System Design Study
Lycans, Randal W., Sverdrup Technology, Inc., USA; 1998; 6p; In English; 7th; Thermophysics Conference, 15-18 Jun. 1998, Albuquerque, NM, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): NAS8-40386; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

The X-33 is an advanced technology demonstrator for validating critical technologies and systems required for an operational Single-Stage-to-Orbit (SSTO) Reusable Launch Vehicle (RLV). Currently under development by a unique contractor/government team led by Lockheed- Martin Skunk Works (LMSW), and managed by Marshall Space Flight Center (MSFC), the X-33 will be the prototype of the first new launch system developed by the USA since the advent of the space shuttle. This paper documents a design trade study of the X-33 base region thermal protection system (TPS). Two candidate designs were evaluated for thermal performance and weight. The first candidate was a fully reusable metallic TPS using Inconel honeycomb panels insulated with high temperature fibrous insulation, while the second was an ablator/insulator sprayed on the metallic skin of the vehicle. The TPS configurations and insulation thickness requirements were determined for the predicted main engine plume heating environments and base region entry aerothermal environments. In addition to thermal analysis of the design concepts, sensitivity studies were performed to investigate the effect of variations in key parameters of the base TPS analysis.
Author
*X-33 Reusable Launch Vehicle; Aerothermodynamics; Honeycomb Structures; Inconel (Trademark); Insulation; Launch Vehicles; Single Stage to Orbit Vehicles; Systems Engineering; Temperature Effects; Thermal Analysis; Thermal Protection*

19980237442 General Accounting Office, National Security and International Affairs Div., Washington, DC USA
Army Aviation: Apache Longbow Weight and Communication Issues
Sep. 1998; 46p; In English
Report No.(s): AD-A353543; GAO/NSIAD-98-203; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Apache Longbow helicopter is designed to conduct precision attacks in adverse weather and on battlefields obscured by smoke, automatically engage multiple targets, and provide fire-and-forget missile capability. The Apache Longbow configuration consists of a modified airframe, a fire control radar, and a new Longbow (radio frequency) Hellfire missile. The Army plans to upgrade the entire fleet of 758 Apache helicopters to the Apache Longbow configuration but outfit only 227 with the radar and a more powerful 701C engine. The remaining 531 non-radar-equipped Apache Longbows will be equipped with the less powerful 701 engine, even though they will be reconfigured to accept the radar and upgraded 701C engine. In its fiscal year 2000-2005 program plan, the Army has proposed a reduction in the number of Apaches that will be converted to the Apache Longbow configuration. The April 1994 Apache Longbow's operational requirements document (ORD) prescribes performance capabilities required for the system's survivability and lethality. These capabilities include meeting the vertical flight requirement, carrying the Longbow Hellfire missile, and passing target data when in line of sight and not in the line of sight. For the Apache Longbow, the Army has identified performance objectives (desired capabilities) and performance thresholds (minimum capabilities). The Army designated selected thresholds as key performance parameters. The Apache Longbow program needs to be reassessed because the helicopter does not meet two key user requirements. The Army's 227 radar-equipped Apache Longbow helicopters will be too heavy to achieve the validated VROC requirement of 450 feet per minute in the combat mission configuration when carrying a full fuel load and 12 missiles.
DTIC
*Helicopters; Attack Aircraft; Weight; Communication*

19980237443 General Accounting Office, National Security and International Affairs Div., Washington, DC USA
Army Aviation: Apache Longbow Weight and Communication Issues
Sep. 1998; 17p; In English; Report to the Secretary of Defense
Report No.(s): AD-A353546; GAO/NSIAD-98-203; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Apache Longbow helicopter is designed to conduct precision attacks in adverse weather and on battlefields obscured by smoke, automatically engage multiple targets, and provide fire-and-forget missile capability. The Apache Longbow configuration consists of a modified airframe, a fire control radar, and a new Longbow (radio frequency) Hellfire missile. The Army plans to upgrade the entire fleet of 758 Apache helicopters to the Apache Longbow configuration but outfit only 227 with the radar and a more powerful 701C engine. The remaining 531 non-radar-equipped Apache Longbows will be equipped with the less powerful 701 engine, even though they will be reconfigured to accept the radar and upgraded 701C engine. In its fiscal year 2000-2005 program plan, the Army has proposed a reduction in the number of Apaches that will be converted to the Apache Longbow configuration. The April 1994 Apache Longbow's operational requirements document (ORD) prescribes performance capabilities required for the system's survivability and lethality. These capabilities include meeting the vertical flight requirement, carrying the Longbow Hellfire missile, and passing target data when in line of sight and not in the line of sight. For the Apache Longbow, the Army has identified performance objectives (desired capabilities) and performance thresholds (minimum capabilities). The Army designated selected thresholds as key performance parameters.
DTIC
*Weight; Communication; Helicopters*

19980237544 Defense Airborne Reconnaissance Office, Washington, DC USA
UAV Annual Report FY 1997, 1997
Nov. 06, 1997; 49p; In English
Report No.(s): AD-A353019; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Airborne reconnaissance is enduring, but it is not unchanging. As we look to the future, we see our mix of airborne reconnaissance assets evolving in response to new technologies as well as joint strategies, doctrine, and a more diverse threat. In this UAV annual Report, our third, we see unmanned aerial vehicles playing an ever-increasing role not only in the intelligence, surveillance and reconnaissance(ISR) world, but in other mission areas as well.
DTIC
*Remotely Piloted Vehicles; Pilotless Aircraft; Reports*

19980237546 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
Aircraft Design Integration and Affordability = *L'integration de la conception aeronautique et le cout de possession acceptable*
Campos, Luis Manuel Braga da Costa, Instituto Superior Tecnico, Portugal; Nov. 1998; 120p; In English
Report No.(s): AGARD-R-826; ISBN 92-836-1065-2; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

This AGARD Advisory Report, was from the Flight Vehicle Integration Panel input to the AGARD study Aerospace "2020". This report examines the difficult questions of capability and affordability. The report focuses on the relevant trends in operational requirements and the technologies available to achieve these requirements. The report considers the affordability of forces as a main issue for the future. Topics include: a discussion in operational requirements, the technology available, advanced structures and materials, systems integration, types of air vehicles, and the affordability of forces. Technologies are assessed from the viewpoints of both potential capabilities and threats. Recommendations and conclusions are presented.
Author
*Technology Assessment; Military Aircraft; Air Defense; Aircraft Design; Aircraft Production Costs; Product Development; Research and Development; Systems Integration*

19980237758 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA
A New Beginning or the End of an Era? Future Use of the C-130 for the Airborne Forcible Entry Capability
Tonrens, Cameron W.; Jun. 1998; 82p; In English
Report No.(s): AD-A354215; AFIT/GMO/LAL/98J-16; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The purpose of this paper is to study the argument over the best use of AMC's newest asset, the C-130 Hercules. History and doctrine appear to support the use of the C-130 in the airborne forcible entry mission. Ill defined requirements and diminishing capabilities of both the C-130 and the airborne division support the search for an alternative mission for the aircraft. History, doctrine, capability, and requirements for the C-130 to perform personnel airdrop are examined. The conclusion examines several

alternatives that could logically result from this debate. These include: (1) the elimination of mass airborne personnel drops as a valid method of forcible entry, (2) maintaining this capability, but eliminating the role of the C-130 in this mission, and (3) maintenance of the status quo continued C-130 support for the airborne division.
DTIC
*Air Drop Operations; Alternatives; C-130 Aircraft*

19980237767 **Defense Advanced Research Projects Agency, Arlington, VA USA**
DarkStar - High Altitude Endurance UAV
**Berman, Harry A.; Defense Advanced Research Projects Agency, USA; Jun. 1997; 13p; In English; Unmanned Vehicles 97 Conference and Exhibition, 12 Jun. 1998, Paris, France**
**Report No.(s): AD-A354166; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche**

This paper describes the U.S. program to develop, test, and demonstrate the Tier 3-, DarkStar, High Altitude Endurance Unmanned Aerial Vehicle (HAE UAV). DarkStar is designed to provide continuous, timely, high resolution imagery products to the Warfighter. DarkStar is uniquely capable of extended surveillance over heavily defended territory. DarkStar is part of the HAE UAV program which also includes the Global Hawk UAV and a common ground segment which is interoperable with both UAVs. It is the combination of DarkStar, Global Hawk and other intelligence, surveillance and reconnaissance assets which will provide U.S. forces with the information dominance, central to future warfighting plans. DARPA is executing the program under Section 845 contracting authority. Air vehicle #1 completed one successful flight and had an accident on the takeoff of flight #2. The accident causes are now well understood. Subsystems and test procedure modifications are being implemented on air vehicle #2. Planning for the programs demonstration phase, FY99-00, is well underway. The USA Atlantic Command has been designated the lead CINC for the system's military evaluation. Specific demonstration exercises are being identified and specific data collection requirements are being developed. The entire DarkStar team is confident that it will demonstrate the performance characteristics which make this a unique and valuable system for protecting and preserving the nation's interests.
DTIC
*High Resolution; High Altitude; Unmanned Spacecraft; Product Development; Performance Tests; Pilotless Aircraft*

19980237883 **Air Force Inst. of Tech., Wright-Patterson AFB, OH USA**
Measuring the Long-Term Effects of Action Workouts
**Malone, Jonathan D.; Sep. 1998; 67p; In English**
**Report No.(s): AD-A354240; AFIT/GAL/LAL/98S-7; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche**

This study analyzed aircraft inspection data to determine if quality enhancements were realized after an Action Workout (AWO) was accomplished. Pretest and post-test assessment data from three separate units were analyzed to determine whether overall quality improvements were made. This study operationally defined quality in terms of Quality Verification Assessment ratings compiled before and after each AWO event. Comparisons were made to determine if overall quality improved, declined, or remained unchanged. Parametric t-tests and nonparametric chi-square analyses were used to determine the significance of any differences between the pretest and post-test data sets. The results provide plausible evidence that quality enhancements can be realized as a result of Action Workouts. Results at two of the three units analyzed indicate that overall quality of major aircraft inspection processes improved considerably, possibly as a result of the Action Workout intervention. Results at the third site, however, remained essentially unchanged. The evidence also suggests that many of the changes and improvement ideas implemented during the AWO are seemingly intact and being utilized by respective maintenance personnel. This may also indicate process owner "buy-in" and acceptance of change, two essential principles of quality improvement. This research establishes a firm foundation for future research efforts.
DTIC
*Inspection; Aircraft Maintenance; Total Quality Management*

19980237928 **Air Force Inst. of Tech., Wright-Patterson AFB, OH USA**
Joint Stars and the Darkstar Unmanned Aerial Vehicle: An Operating and Support Cost Estimate
**SIKRA, JAMES W.; Sep. 1998; 94p; In English**
**Report No.(s): AD-A354283; AFIT/GSM/LAS/98S-2; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche**

With the 1997 Quadrennial Defense Review's (QDR) reduction of Joint STARS aircraft from 19 to 13, the program will not be able to maintain the Department of Defense requirement to fully support two major theater wars (MTWs). One strategy is to supplement Joint STARS with long-endurance unmanned aerial vehicles (UAVs). One particular UAV, the Low Observable High-Altitude Endurance (LO HAE) Tier III Minus "DarkStar," is capable of filling in the coverage gap left by the QDR's decision, and potentially replacing the Joint STARS system one day if certain capabilities are expanded. This study provides a brief history

of UAVs to date, leading up to where the technology is today. It compares the annual operating and support (O&S) costs for the Joint STARS and DarkStar programs in fiscal year (FY) 1998 dollars using the Cost-Oriented Resource Estimating (CORE) model. A potential 2006 force structure is used as the scenario, when all 13 Joint STARS aircraft are to be delivered and 12 DarkStars can be available. The Joint STARS model is measured against an O&S cost estimate provided by the Joint STARS Joint Program Office (JPO) for validation of the CORE model. The JPO's annual cost estimate was $269.3 M vs. CORE's $271.3 M, a difference of only 0.7%. The DarkStar estimate was $54.8M, an inexpensive solution compared to procuring another six Joint STARS aircraft.
DTIC
*Cost Estimates; Operating Costs; Pilotless Aircraft*

19980237945 **Bell Helicopter Co., Fort Worth, TX USA**
Evaluation of Navy 9 cst Oil in Bell Helicopter M412 HP Gearboxes *Final Report*
**Zachary, S. H., Bell Helicopter Co., USA; Stapper, William R., Bell Helicopter Co., USA; Aug. 1998; 20p; In English**
Contracts/Grants(s): NAS3-25455; Proj. IL1462211-A-47-A; RTOP 581-80-13
Report No.(s): NASA/CR-1998-208517; NAS 1.26:208517; E-11296; ARL-CR-430; AD-A351965; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
Tests were conducted with 5 and 9 centistoke lubricants in three different helicopter gearboxes, a main transmission, a 42° gearbox and a tailrotor gearbox. The objective of the tests was to observe and measure the difference in the performance of the lubrication systems due to the viscosity difference between the two test lubricants. The 9 centistoke oil has been developed to provide higher component film thickness, increased load carrying capacity and improved corrosion resistance which will provide increased life for drive system gears and bearings.
DTIC
*Bell Aircraft; Oils; Gears; Helicopters; Transmission Fluids; Transmissions (Machine Elements)*

## 06
## AIRCRAFT INSTRUMENTATION

*Includes cockpit and cabin display devices, and flight instruments.*

19980237582 **Colorado Univ., Colorado Springs, CO USA**
Real Time Information into the Cockpit: A Conceptual Overview
**Bishop, Benjamin W., Colorado Univ., USA; May 20, 1998; 109p; In English**
Report No.(s): AD-A358053; CU-98-006; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche
This investigation discusses several issues pertaining to the distribution of Real time Information into the Cockpit (RTIC). Specifically, attention is focused on the vision of this new technology and how it applies to the USA Air Force. The concept is defined and discussed as it applies the Air Force's core competencies. The attributes characterizing push versus pull architectures are also depicted. In addition, the supporting grid, which will be the foundation of these new technologies, is reviewed. In particular, the requirements and current limitations of implementing the grid are discussed. Finally, the process of implementing an RTIC process in an operational context is outlined. The data collection, fusion, and dissemination phases are analyzed against the backdrop of a U-2 to F-16 sensor to shooter scenario.
DTIC
*Real Time Operation; Cockpits; Information Transfer; Research*

## 07
## AIRCRAFT PROPULSION AND POWER

*Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.*

19980237011 **NASA Lewis Research Center, Cleveland, OH USA**
GaAs/Ge Solar Powered Aircraft
**Colozza, Anthony J., Federal Data Corp., USA; Scheiman, David A., Federal Data Corp., USA; Brinker, David J., NASA Lewis Research Center, USA; Oct. 1998; 17p; In English**
Contracts/Grants(s): RTOP 477-72-10

Report No.(s): NASA/TM-1998-208652; NAS 1.15:208652; E-11371; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Unmanned Aerial Vehicles (UAV) are being proposed for many applications for many applications including surveillance, mapping and atmospheric studies. These applications require a lightweight, low speed, medium to long duration aircraft. Due to the weight, speed, and altitude constraints imposed on such an aircraft, solar array generated electric power can be a viable alternative to air-breathing engines for certain missions. Development of such an aircraft is currently being funded under the Environmental Research Aircraft and Sensor Technology (ERAST) program. NASA Lewis Research Center (LeRC) has built a Solar Electric Airplane to demonstrate UAV technology. This aircraft utilizes high efficiency Applied Solar Energy Corporation (ASEC) GaAs/Ge space solar cells. The cells have been provided by the Air Force through the ManTech Office.

Author

*Gallium Arsenides; Solar Cells; Solar Arrays; Solar Powered Aircraft; Solar Propulsion; Solar Electric Propulsion*

19980237202 NASA Lewis Research Center, Cleveland, OH USA

High Stability Engine Control (HISTEC): Flight Demonstration Results

**Delaat, John C., NASA Lewis Research Center, USA; Southwick, Robert D., United Technologies Corp., USA; Gallops, George W., United Technologies Corp., USA; Orme, John S., NASA Dryden Flight Research Center, USA; Sep. 1998; 14p; In English; 1998 World Aviation Congress and Exposition, 28-30 Sep. 1998, Anaheim, CA, USA; Sponsored by Society of Automotive Engineers, Inc., USA; Original contains color illustrations**

Contract(s)/Grant(s): RTOP 523-53-13

Report No.(s): NASA/TM-1998-208655; NAS 1.15:208655; SAE-985556; E-11375; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Future aircraft turbine engines, both commercial and military, must be able to accommodate expected increased levels of steady-state and dynamic engine-face distortion. The current approach of incorporating sufficient design stall margin to tolerate these increased levels of distortion would significantly reduce performance. The High Stability Engine Control (HISTEC) program has developed technologies for an advanced, integrated engine control system that uses measurement- based estimates of distortion to enhance engine stability. The resulting distortion tolerant control reduces the required design stall margin, with a corresponding increase in performance and/or decrease in fuel burn. The HISTEC concept was successfully flight demonstrated on the F-15 ACTIVE aircraft during the summer of 1997. The flight demonstration was planned and carried out in two parts, the first to show distortion estimation, and the second to show distortion accommodation. Post-flight analysis shows that the HISTEC technologies are able to successfully estimate and accommodate distortion, transiently setting the stall margin requirement on-line and in real-time. Flight demonstration of the HISTEC technologies has significantly reduced the risk of transitioning the technology to tactical and commercial engines

Author

*Aircraft Engines; Turbine Engines; Gas Turbine Engines; Flight Tests; Engine Control; Fuel Consumption; Flow Characteristics; Flow Distortion*

## 08
## AIRCRAFT STABILITY AND CONTROL

*Includes aircraft handling, qualities, piloting, flight controls, and autopilots.*

19980237256 NASA Marshall Space Flight Center, Huntsville, AL USA

X-33 Attitude Control System Design for Ascent, Transition, and Entry Flight Regimes

**Hall, Charles E., NASA Marshall Space Flight Center, USA; Gallaher, Michael W., NASA Marshall Space Flight Center, USA; Hendrix, Neal D., NASA Marshall Space Flight Center, USA; 1998; 11p; In English; GN and C Conference, 11 Aug. 1998, Boston, MA, USA; Sponsored by NASA Marshall Space Flight Center, USA**

Report No.(s): AIAA Paper 98-4411; Copyright Waived; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Vehicle Control Systems Team at Marshall Space Flight Center, Systems Dynamics Laboratory, Guidance and Control Systems Division is designing under a cooperative agreement with Lockheed Martin Skunkworks, the Ascent, Transition, and Entry flight attitude control system for the X-33 experimental vehicle. Ascent flight control begins at liftoff and ends at linear aerospike main engine cutoff (MECO) while Transition and Entry flight control begins at MECO and concludes at the terminal area energy management (TAEM) interface. TAEM occurs at approximately Mach 3.0. This task includes not only the design of the vehicle attitude control systems but also the development of requirements for attitude control system components and subsystems. The X-33 attitude control system design is challenged by a short design cycle, the design environment (Mach 0 to about

Mach 15, and the X-33 incremental test philosophy. The X-33 design-to-launch cycle of less than 3 years requires a concurrent design approach while the test philosophy requires design adaptation to vehicle variations that are a function of Mach number and mission profile. The flight attitude control system must deal with the mixing of aerosurfaces, reaction control thrusters, and linear aerospike engine control effectors and handle parasitic effects such as vehicle flexibility and propellant sloshing from the uniquely shaped propellant tanks. The attitude control system design is, as usual, closely linked to many other subsystems and must deal with constraints and requirements from these subsystems.

Author

*X-33 Reusable Launch Vehicle; Aerospike Engines; Propellant Tanks; Mach Number; Flight Control; Engine Control; Control Systems Design; Attitude Control*

19980237343 Rensselaer Polytechnic Inst., Troy, NY USA

Assessment Study of the State of the Art in Adaptive Control and its Applications to Aircraft Control *Final Report, 1 May - 31 Dec. 1998*

Kaufman, Howard, Rensselaer Polytechnic Inst., USA; 1998; 23p; In English

Contract(s)/Grant(s): NAG1-2075; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Many papers relevant to reconfigurable flight control have appeared over the past fifteen years. In general these have consisted of theoretical issues, simulation experiments, and in some cases, actual flight tests. Results indicate that reconfiguration of flight controls is certainly feasible for a wide class of failures. However many of the proposed procedures although quite attractive, need further analytical and experimental studies for meaningful validation. Many procedures assume the availability of failure detection and identification logic that will supply adequately fast, the dynamics corresponding to the failed aircraft. This in general implies that the failure detection and fault identification logic must have access to all possible anticipated faults and the corresponding dynamical equations of motion. Unless some sort of explicit on line parameter identification is included, the computational demands could possibly be too excessive. This suggests the need for some form of adaptive control, either by itself as the prime procedure for control reconfiguration or in conjunction with the failure detection logic. If explicit or indirect adaptive control is used, then it is important that the identified models be such that the corresponding computed controls deliver adequate performance to the actual aircraft. Unknown changes in trim should be modelled, and parameter identification needs to be adequately insensitive to noise and at the same time capable of tracking abrupt changes. If however, both failure detection and system parameter identification turn out to be too time consuming in an emergency situation, then the concepts of direct adaptive control should be considered. If direct model reference adaptive control is to be used (on a linear model) with stability assurances, then a positive real or passivity condition needs to be satisfied for all possible configurations. This condition is often satisfied with a feedforward compensator around the plant. This compensator must be robustly designed such that the compensated plant satisfies the required positive real conditions over all expected parameter values. Furthermore, with the feedforward only around the plant, a nonzero (but bounded error) will exist in steady state between the plant and model outputs. This error can be removed by placing the compensator also in the reference model. Design of such a compensator should not be too difficult a problem since for flight control it is generally possible to feedback all the system states.

Author

*Fault Detection; Aircraft Control; Adaptive Control; Feedforward Control; Flight Control; Parameter Identification; Model Reference Adaptive Control*

19980237451 California Univ., Dept. of Mechanical, Aerospace and Nuclear Engineering, Los Angeles, CA USA

Eulerian-Lagrangian Simulations of Transonic Flutter Instabilities

Bendiksen, Oddvar O., California Univ., USA; 1994; 35p; In English; Fluid-Structure Interaction and Aeroelasticity, 11 Nov. 1994, Chicago, IL, USA; Sponsored by American Society of Mechanical Engineers, USA

Contract(s)/Grant(s): NCC2-374; NAS3-25574; NAS3-26086; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This paper presents an overview of recent applications of Eulerian-Lagrangian computational schemes in simulating transonic flutter instabilities. This approach, the fluid-structure system is treated as a single continuum dynamics problem, by switching from an Eulerian to a Lagrangian formulation at the fluid-structure boundary. This computational approach effectively eliminates the phase integration errors associated with previous methods, where the fluid and structure are integrated sequentially using different schemes. The formulation is based on Hamilton's Principle in mixed coordinates, and both finite volume and finite element discretization schemes are considered. Results from numerical simulations of transonic flutter instabilities are presented for isolated wings, thin panels, and turbomachinery blades. The results suggest that the method is capable of reproducing the energy exchange between the fluid and the structure with significantly less error than existing methods. Localized flutter modes

and panel flutter modes involving traveling waves can also be simulated effectively with no a priori knowledge of the type of instability involved.
Author
*Lagrangian Function; Finite Volume Method; Panel Flutter; Transonic Flutter; Turbomachinery; Wings*

19980237857 NASA Langley Research Center, Hampton,VA USA
On the Numerical Formulation of Parametric Linear Fractional Transformation (LFT) Uncertainty Models for Multivariate Matrix Polynomial Problems
**Belcastro, Christine M., NASA Langley Research Center, USA; Nov. 1998; 39p; In English**
Contract(s)/Grant(s): RTOP 522-35-11-01
Report No.(s): NASA/TM-1998-206939; L-17729; NAS 1.15:206939; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Robust control system analysis and design is based on an uncertainty description, called a linear fractional transformation (LFT), which separates the uncertain (or varying) part of the system from the nominal system. These models are also useful in the design of gain-scheduled control systems based on Linear Parameter Varying (LPV) methods. Low-order LFT models are difficult to form for problems involving nonlinear parameter variations. This paper presents a numerical computational method for constructing and LFT model for a given LPV model. The method is developed for multivariate polynomial problems, and uses simple matrix computations to obtain an exact low-order LFT representation of the given LPV system without the use of model reduction. Although the method is developed for multivariate polynomial problems, multivariate rational problems can also be solved using this method by reformulating the rational problem into a polynomial form.
Author
*Direct Numerical Simulation; Computerized Simulation; Robustness (Mathematics); Linear Transformations; Control Systems Design; Matrices (Mathematics); Mathematical Models*

## 09
## RESEARCH AND SUPPORT FACILITIES (AIR)

*Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels, shock tubes, and aircraft engine test stands.*

19980237120 Institute for Human Factors TNO, Soesterberg, Netherlands
Low-Cost Simulators Ib: Task- and Cost-Utility Data of a Driver Training and UAV-Operator Training Course *Final Report Low-Cost Simulatoren Ib: Taak- en Kosten-Baten Informatie van een Militaire Rijopleiding en Opleiding voor Bestuuring van Onbemande Vliegtuigen*
**Helsdingen, A. S., Institute for Human Factors TNO, Netherlands; Korteling, J. E., Institute for Human Factors TNO, Netherlands; vandenBosch, K., Institute for Human Factors TNO, Netherlands; Jan. 20, 1998; 47p; In English**
Contract(s)/Grant(s): A96/CO/363; TNO Proj. 788.1
Report No.(s): TD98-0006; TM-98-A002; Copyright; Avail: Issuing Activity (TNO Human Factors Research Inst., Kampweg 5, 3769 De Soesterberg, The Netherlands), Hardcopy, Microfiche

To investigate possibilities for application of low-cost simulators within military training courses, a research project called ELSTAR (European Low - cost Simulation Technology for the ARmed forces) is carried out under contract of the Ministries of Defence of the five participating countries of Research Technology Project (RTP) 11.8, viz. Belgium, France, Greece, Germany, and The Netherlands. For this investigation a taxonomy constituting 100 military task domains was developed and those domains were evaluated on 15 criteria relevant for low-cost simulator applications. Thus a representative and concise set of 9 military training areas was defined that covered the 29 selected task domains. The present report describes the method of information acquisition and the resulting concrete data concerning two specific training programs, within the above mentioned 9 training areas, that were investigated by TNO-HFR1. This will constitute the basis of the training- and cost-utility analysis that will be carried out in the subsequent activity of the present work package (i.e. WP1.c). The selection of the task domains and training areas that was made in the previous activity of this work package seems to be validated by the current results, both training areas show elements that are suitable for the application of low-cost simulation. Still, based on the current results no conclusions can be made as to which training area would be most fit for application of low-cost simulation. The cost-utility analyses and the training analyses that will be made in the subsequent activity of this work package (i.e. WP1.c) will provide more decisive answers on this matter.
Author
*Cost Analysis; Low Cost; Simulators; Data Acquisition; Training Analysis; Research and Development*

19980237278 NASA Langley Research Center, Hampton, VA USA

The Langley Wind Tunnel Enterprise

Paulson, John W., Jr., NASA Langley Research Center, USA; Kumar, Ajay, NASA Langley Research Center, USA; Kegelman, Jerome T., NASA Langley Research Center, USA; 1998; 24p; In English; 89th; Supersonic Tunnel Association, 26-28 Apr. 1998, Brussels, Belgium; Sponsored by Von Karman Inst. for Fluid Dynamics, Belgium

Report No.(s): NASA/CR-1998-207800; NAS 1.26:207800; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

After 4 years of existence, the Langley WTE is alive and growing. Significant improvements in the operation of wind tunnels have been demonstrated and substantial further improvements are expected when we are able to truly address and integrate all the processes affecting the wind tunnel testing cycle.

Author

*Wind Tunnel Tests; Wind Tunnels*

19980237332 Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia

A Computer Control Interface to Operate Turntables in the Test Section of a Wind Tunnel

Kent, S. A., Defence Science and Technology Organisation, Australia; May 1998; 45p; In English; Original contains color illustrations

Report No.(s): DSTO-TR-0622; DODA-AR-010-528; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

The Low Speed Wind Tunnel at the Aeronautical and Maritime Research Laboratory (AMRL) has, as part of its system, two interchangeable chambers, known as "test sections" where models to be tested are mounted. One of the requirements of a recent upgrade to the Low Speed Wind Tunnel control and data acquisition system was the ability to precisely position the turntables using computer control. This report describes the electronic hardware and software developed to enable computer control of the turntables by wind tunnel personnel.

Author

*Computer Programs; Speed Control; Numerical Control; Data Acquisition*

19980237975 Old Dominion Univ., Dept. of Aerospace Engineering, Norfolk, VA USA

Magnetic Suspension Technology Development *Final Report, 1 Jan. 1997 - 31 May 1998*

Britcher, Colin, Old Dominion Univ., USA; Aug. 1998; 65p; In English

Contract(s)/Grant(s): NCC1-248; ODURF Proj. 170051; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This Cooperative Agreement, intended to support focused research efforts in the area of magnetic suspension systems, was initiated between NASA Langley Research Center (LaRC) and Old Dominion University (ODU) starting January 1, 1997. The original proposal called for a three-year effort, but funding for the second year proved to be unavailable, leading to termination of the agreement following a 5-month no-cost extension. This report covers work completed during the entire 17-month period of the award. This research built on work that had taken place over recent years involving both NASA LARC and the Principal Investigator (PI). The research was of a rather fundamental nature, although specific applications were kept in mind at all times, such as wind tunnel Magnetic Suspension and Balance Systems (MSBS), space payload pointing and vibration isolation systems, magnetic bearings for unconventional applications, magnetically levitated ground transportation and electromagnetic launch systems. Fundamental work was undertaken in areas such as the development of optimized magnetic configurations, analysis and modelling of eddy current effects, control strategies for magnetically levitated wind tunnel models and system calibration procedures. Despite the termination of this Cooperative Agreement, several aspects of the research work are currently continuing with alternative forms of support.

Author

*Magnetic Suspension; Magnetic Bearings; Eddy Currents; Surface Vehicles*

# 10
# ASTRONAUTICS

*Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.*

19980236998 NASA Langley Research Center, Hampton, VA USA
A Passive Earth-Entry Capsule for Mars Sample Return
Mitcheltree, R. A., NASA Langley Research Center, USA; Kellas, S., Lockheed Martin Engineering and Sciences Co., USA; Dorsey, J. T., NASA Langley Research Center, USA; Desai, P. N., NASA Langley Research Center, USA; Martin, C. J., NASA Langley Research Center, USA; 1998; 13p; In English; 7th; Thermophysics and Heat Transfer, 15-18 Jun. 1998, Albuquerque, NM, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Report No.(s): AIAA Paper 98-2851; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

A combination of aerodynamic analysis and testing, aerothermodynamic analysis, structural analysis and testing, impact analysis and testing, thermal analysis, ground characterization tests, configuration packaging, and trajectory simulation are employed to determine the feasibility of an entirely passive Earth entry capsule for the Mars Sample Return mission. The design circumvents the potential failure modes of a parachute terminal descent system by replacing that system with passive energy absorbing material to cushion the Mars samples during ground impact. The suggested design utilizes a spherically blunted 45 degree half-angle forebody with an ablative heat-shield. The primary structure is a spherical composite sandwich enclosing carbon foam energy absorbing material. Though no demonstration test of the entire system is included, results of the testing and analysis presented indicate that the design is a viable option for the Mars Sample Return Mission.
Author
*Mars Sample Return Missions; Mars Surface Samples; Sandwich Structures; Heat Shielding; Absorbers (Materials); Aerodynamic Characteristics; Aerothermodynamics; Atmospheric Entry; Structural Analysis; Thermal Analysis*

19980237004 Alabama Univ., Huntsville, AL USA
Experimental Investigation of an Integrated Strut-Rocket/Scramjet Operating at Mach 4.0 and 6.5 Conditions
Hawk, Clark, Alabama Univ., USA; Nelson, Karl, Alabama Univ., USA; 1998; 17p; In English; Joint Propulsion Meeting, 15-17 Jul. 1998, Cleveland, OH, USA; Sponsored by Department of the Navy, USA
Contract(s)/Grant(s): NGT-51371; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A series of tests were conducted to investigate RBCC performance at ramjet and scramjet conditions. The hardware consisted of a linear strut-rocket manufactured by Aerojet and a dual-mods scramjet combustor. The hardware was tested at NASA Langley Research Center in the Direct Connect Supersonic Combustion Test Facility at Mach 4.0 and 6.5 simulated flight conditions.
Author
*Ramjet Engines; Supersonic Combustion Ramjet Engines; Combustion Chambers; Struts; Supersonic Combustion*

19980237005 NASA Marshall Space Flight Center, Huntsville, AL USA
Propellant Feed Subsystem for the X-34 Main Propulsion System
McDonald, J. P., Sverdrup Technology, Inc., USA; Minor, R. B., Sverdrup Technology, Inc., USA; Knight, K. C., Sverdrup Technology, Inc., USA; Champion, R. H., Jr., NASA Marshall Space Flight Center, USA; Russell, F. J., Jr., NASA Marshall Space Flight Center, USA; 1998; 11p; In English; 34th; Joint Propulsion Conference and Exhibit, 13-15 Jul. 1998, Cleveland, OH, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): NAS8-40836
Report No.(s): AIAA Paper 98-3517; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Orbital Sciences Corporation X-34 vehicle demonstrates technologies and operations key to future reusable launch vehicles. The general flight performance goal of this unmanned rocket plane is Mach 8 flight at an altitude of 250,000 feet. The Main Propulsion System supplies liquid propellants to the main engine, which provides the primary thrust for attaining mission goals. Major NMS design and operational goals are aircraft-like ground operations, quick turnaround between missions, and low initial/operational costs. This paper reviews major design and analysis aspects of the X-34 propellant feed subsystem of the X-34 Main Propulsion System. Topics include system requirements, system design, the integration of flight and feed system performance, propellant acquisition at engine start, and propellant tank terminal drain.
Author
*X-34 Reusable Launch Vehicle; Reusable Launch Vehicles; Flight Characteristics; Hypersonic Speed; Liquid Rocket Propellants; Propulsion System Configurations; Propulsion System Performance*

19980237254 Lockheed Martin Michoud Space Systems, New Orleans, LA USA

Dual Liquid Flyback Booster for the Space Shuttle

Blum, C., Lockheed Martin Michoud Space Systems, USA; Jones, P., Lockheed Martin Michoud Space Systems, USA; Meinders, B., Lockheed Martin Michoud Space Systems, USA; 1998; 11p; In English; Joint Propulsion Meeting, 16-17 Jul. 1998, Cleveland, OH, USA; Sponsored by Department of the Army, USA

Contract(s)/Grant(s): NAS8-97259; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Liquid Flyback Boosters provide an opportunity to improve shuttle safety, increase performance, and reduce operating costs. The objective of the LFBB study is to establish the viability of a LFBB configuration to integrate into the shuffle vehicle and meet the goals of the Space Shuttle upgrades program. The design of a technically viable LFBB must integrate into the shuffle vehicle with acceptable impacts to the vehicle elements, i.e. orbiter and external tank and the shuttle operations infrastructure. The LFBB must also be capable of autonomous return to the launch site. The smooth integration of the LFBB into the space shuttle vehicle and the ability of the LFBB to fly back to the launch site are not mutually compatible capabilities. LFBB wing configurations optimized for ascent must also provide flight quality during the powered return back to the launch site. This paper will focus on the core booster design and ascent performance. A companion paper 'Conceptual Design for a Space Shuttle Liquid Flyback Booster' will focus on the flyback system design and performance. The LFBB study developed design and aerodynamic data to demonstrate the viability of a dual booster configuration to meet the shuttle upgrade goals, i.e. enhanced safety, improved performance and reduced operations costs.

Author

*Space Transportation System Flights; Space Shuttle Boosters; Space Shuttles; Flight Characteristics; External Tanks; Aerodynamics; Aerodynamic Configurations*

19980237339 NASA Marshall Space Flight Center, Huntsville, AL USA

The Advanced Reusable Technologies Project *Progress Report*

Turner, James E., NASA Marshall Space Flight Center, USA; Hueter, Uwe, NASA Marshall Space Flight Center, USA; 1998; 8p; In English; 34th; Propulsion, 13-15 Jul. 1998, Cleveland, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): NAS8-40891

Report No.(s): AIAA Paper 98-3227; Copyright Waived; Avail: CASI; A02, Hardcopy; A01, Microfiche

Currently, NASA and its industry partners are performing ground testing of hydrogen-fueled rocket based combined-cycle flowpaths. Successful ramjet and scramjet testing at Mach 6 and scramjet testing at Mach 8 have been performed. Cold flow mixing tests have also been successfully performed as have inlet operability tests. Additional testing of RBCC flowpaths at air augmented rocket and rocket only modes is underway.

Author

*Supersonic Combustion Ramjet Engines; Ramjet Engines; Rocket Engines*

19980237341 NASA Marshall Space Flight Center, Huntsville, AL USA

X-33 Trajectory Optimization and Design

Hill, Ashley D., Sverdrup Technology, Inc., USA; Anderson, David M., NASA Marshall Space Flight Center, USA; Coughlin, Dan J., NASA Marshall Space Flight Center, USA; Chowdhry, Rajiv S., Lockheed Martin Corp., USA; 1998; 13p; In English; Guidance Navigation and Control, 10-12 Aug. 1998, Boston, MA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): NCC8-115

Report No.(s): AIAA Paper 98-4408; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

The X-33 vehicle is, designed to provide induced environments similar to those expected for the Lockheed Martin VentureStar Reusable Launch Vehicle (RLV). The sub-orbital trajectories for the X- 33 are designed to evaluate materials and technology for RLV and are subject to aerodynamic, aeroheating and structural loading constraints assuring the environments generated are within the capabilities of the vehicle. The trajectories are required to provide enough energy to the vehicle to reach its intended landing site in the presence of ascent and reentry dispersions. The scope of the trajectories covers liftoff through ascent, transition, and reentry to the Terminal Area Energy Management (TAEM) interface, where the landing phase begins. Trajectory optimization is accomplished through the use of the three degree-of- freedom (3-DOF) versions of Program to Optimize Simulated Trajectories (POST) and Optimal Trajectories by Implicit Simulation (OTIS) computer codes. Five sets of mission objectives were downselected for detailed trajectory design, providing a means of performing initial flights of the vehicle and subsequent flight envelope expansion missions approaching design limits of the vehicle. All flight designs recover the X-33 via horizontal runway landing

at Michael Army Air Field, Utah. The flight designs presented here are nominal reference trajectories with no dispersions introduced.
Author
*X-33 Reusable Launch Vehicle; Trajectory Optimization; Reusable Launch Vehicles; Flight Envelopes; Computerized Simulation; Computer Programs; Aerodynamic Heating*

19990037415 NASA Goddard Space Flight Center, Greenbelt, MD USA
The Software Design for the Wide-Field Infrared Explorer Attitude Control System
Anderson, Mark O., NASA Goddard Space Flight Center, USA; Barnes, Kenneth C., Hammers Co., USA; Melhorn, Charles M., Hammers Co., USA; Phillips, Tom, Hammers Co., USA; Mar. 17, 1998; 16p; In English; 12th; Small Satellites, 31 Aug. 1998, Logan, UT, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Wide-Field Infrared Explorer (WIRE), currently scheduled for launch in September 1998, is the fifth of five spacecraft in the NASA/Goddard Small Explorer (SMEX) series. This paper presents the design of WIRE's Attitude Control System flight software (ACS FSW). WIRE is a momentum-biased, three-axis stabilized stellar pointer which provides high-accuracy pointing and autonomous acquisition for eight to ten stellar targets per orbit. WIRE's short mission life and limited cryogen supply motivate requirements for Sun and Earth avoidance constraints which are designed to prevent catastrophic instrument damage and to minimize the heat load on the cryostat. The FSW implements autonomous fault detection and handling (FDH) to enforce these instrument constraints and to perform several other checks which insure the safety of the spacecraft. The ACS FSW implements modules for sensor data processing, attitude determination, attitude control, guide star acquisition, actuator command generation, command/telemetry processing, and FDH. These software components are integrated with a hierarchical control mode managing module that dictates which software components are currently active. The lowest mode in the hierarchy is the 'safest' one, in the sense that it utilizes a minimal complement of sensors and actuators to keep the spacecraft in a stable configuration (power and pointing constraints are maintained). As higher modes in the hierarchy are achieved, the various software functions are activated by the mode manager, and an increasing level of attitude control accuracy is provided. If FDH detects a constraint violation or other anomaly, it triggers a safing transition to a lower control mode. The WIRE ACS FSW satisfies all target acquisition and pointing accuracy requirements, enforces all pointing constraints, provides the ground with a simple means for reconfiguring the system via table load, and meets all the demands of its real-time embedded environment (16 MHz Intel 80386 processor with 80387 coprocessor running under the VRTX operating system). The mode manager organizes and controls all the software modules used to accomplish these goals, and in particular, the FDH module is tightly coupled with the mode manager.
Author
*Applications Programs (Computers); Software Engineering; Spacecraft Configurations; Wire; Telemetry; Infrared Radiation; Infrared Instruments; Flight Control; Computer Programs; Attitude Control; Actuators*

## 11
## CHEMISTRY AND MATERIALS

*Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.*

19990037402 Princeton Univ., Dept. of Material and Aerospace Engineering, NJ USA
Fuels Combustion Research, Supercritical Fuel Pyrolysis *Progress Report, 1 Sep. 1997 - 31 Aug. 1998*
Glassman, Irvin; Aug. 28, 1998; 9p; In English
Contract(s)/Grant(s): F49620-98-1-0134; AF Proj. 2308
Report No.(s): AD-A353435; AFRL-SR-BL-TR-98-0629; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Concentrating on the problem of fuel line fouling possible in the next generation aircraft gas turbines, extensive experimentation on the pyrolysis of the endothermic fuels, methylcyclohexane, decalin and tetraline under sub and supercritical was completed. Results revealed that the fuel decomposition rates had an activation energy essentially the same for all fuels and cases, but that the pre-exponential factor was two orders of magnitude higher under supercritical conditions. Although the pyrolysis products were generally the same, higher order cyclic hydrocarbons were found under supercritical conditions. These compounds were also found to have lead to known precursors for particulate formation and to have increased with increasing pressure. These differences between sub and supercritical conditions have been postulated to be due to the phenomenon known as caging at high pressures.
DTIC
*Combustion; Pyrolysis; Aircraft Engines; Endothermic Fuels*

## 12
## ENGINEERING

*Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.*

19980237257 NASA Lewis Research Center, Cleveland, OH USA

Digital PIV Measurements in the Diffuser of a High Speed Centrifugal Compressor

**Wernet, Mark P., NASA Lewis Research Center, USA; 1998; 12p; In English; 20th; Advanced Measurement and Ground Testing Technology, 15-18 Jun. 1998, Albuquerque, NM, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA**

**Contract(s)/Grant(s): RTOP 519-20-53**

**Report No.(s): AIAA Paper 98-2777; No Copyright; Avail: Issuing Activity, Hardcopy, Microfiche**

Particle Imaging Velocimetry (PIV) is a powerful measurement technique which can be used as an alternative or complementary approach to Laser Doppler Velocimetry (LDV) in a wide range of research applications. PIV data are measured simultaneously at multiple points in space, which enables the investigation of the non-stationary spatial structures typically encountered in turbomachinery. Obtaining ample optical access, sufficiently high seed particle concentrations and accurate synchronization of image acquisition relative to impeller position are the most formidable tasks in the successful implementation of PIV in turbomachinery. Preliminary results from the successful application of the standard 2-D digital PIV technique in the diffuser of a high speed centrifugal compressor are presented. Instantaneous flow measurements were also obtained during compressor surge. **Author**

*Laser Doppler Velocimeters; Particle Image Velocimetry; Centrifugal Compressors; Turbomachinery; Digital Techniques*

19980237263 Cincinnati Univ., OH USA

Development of a Vorticity-Velocity Navier-Stokes Formulation for the Study of Compressibility Effects on Dynamic Stall, *1 Sep. 1994 - 29 Feb. 1996*

**Ghia, K. N., Cincinnati Univ., USA; Ghia, U., Cincinnati Univ., USA; Jul. 1996; 21p; In English**

**Contract(s)/Grant(s): NCC2-5086; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche**

The first major area of this study was to develop a vorticity-velocity formulation and numerical solution algorithms suitable for the analyses of incompressible as well as low-to- moderate-speed compressible flows. Research performed towards contributing to the determination of the appropriate vorticity and dilation creation boundary conditions suggested to temporarily set aside this approach and use a primitive-variable approach other than the pseudo-compressibility approach used. The second major area of study was initiated to comprehensively examine the INS-2D and INS-3D programs from the point of view of boundary conditions. The research carried out was documented in the form of two technical papers which are included in Appendices A and B; the boundary-condition related issues for INS-3D are briefly mentioned. **Author**

*Vorticity; Vortices; Navier-Stokes Equation; Compressibility Effects; Aerodynamic Stalling; Direct Numerical Simulation; Computational Fluid Dynamics*

19980237452 NASA Goddard Space Flight Center, Greenbelt, MD USA

Analysis of the Cyclotron Facility Calibration and Aircraft Results Obtained by LIULIN-3M Instrument

**Dachev, T. P., Bulgarian Academy of Sciences, Bulgaria; Stassinopoulos, E. G., NASA Goddard Space Flight Center, USA; Tomov, B. T., Bulgarian Academy of Sciences, Bulgaria; Dimitrov, P. G., Bulgarian Academy of Sciences, Bulgaria; Matviichuk, Y. N., Bulgarian Academy of Sciences, Bulgaria; Shurshakov, V. A., Institute of Biomedical Problems, USSR; Petrov, V. M., Institute of Biomedical Problems, USSR; 1998; 4p; In English; Advances in space Research, 12-19 Jul. 1998, Nagoya, Japan; Sponsored by Committee on Space Research, France**

**Contract(s)/Grant(s): NZ-701; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche**

The LIULIN-3M instrument is a further development of the LIULIN dosimeter-radiometer, which has been used on the NffR space station in the 1988-1994 time period. The LIULIN-3M is designed for continuous monitoring of the radiation environment during the BION-12 satellite flight in 1989. A semiconductor detector with 1 mm thickness and 1 cm(exp 2) area is used in the instrument. Pulse high analysis technique is used for measurement of the energy losses in the detector. The final data sets from the instrument are the flux and the dose rate for the exposition time and 256 channels of LET spectra if a non-nal coincidence of the particles to the detector is considered. The LIULIN-3M instrument was calibrated by proton fluxes with different energies at

the Indiana University Cyclotron Facility in June 1997 and was used for space radiation measurements during commercial aircraft flights. Obtained calibration and flight results are analyzed in the paper.
Author
*Commercial Aircraft; Calibrating; Cyclotrons; Semiconductors (Materials); Thickness*

19980237453 NASA Goddard Space Flight Center, Greenbelt, MD USA
Miniature High-Let Radiation Spectrometer for Space and Avionics Applications
Stassinopoulos, E. G., NASA Goddard Space Flight Center, USA; Stauffer, Craig A., Systems Engineering and Security, Inc., USA; Brucker, G. J., Radiation Effects Consultants, USA; 1998; 12p; In English; Nuclear Instruments and Methods in Physics Research, Unknown; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This paper reports on the design and characterization of a small, low power, and low weight instrument, a High-LET Radiation Spectrometer (HILRS), that measures energy deposited by heavy ions in microelectronic devices. The HILRS operates on pulse-height analysis principles and is designed for space and avionics applications. The detector component in the instrument is based on large scale arrays of p-n junctions. In this system, the pulse amplitude from a particle hit is directly proportional to the particle LET. A prototype flight unit has been fabricated and calibrated using several heavy ions with varying LETs and protons with several energies. The unit has been delivered to the Ballistic Missile Defense Organization (BMDO) c/o the Air Force Research Laboratory in Albuquerque, NM, for integration into the military Space Technology Research Vehicle (STRV), a US-UK cooperative mission. Another version of HILRS is being prepared for delivery in April to the Hubble Space Telescope (HST) project, to fly on the HST Orbital Systems Test (HOST) Platform on a shuttle mission.
Author
*Space Transportation System Flights; Research Vehicles; Missile Defense; Miniaturization; Military Technology; Microelectronics; Hubble Space Telescope; Ballistic Missiles; Avionics; Aerospace Engineering*

19980237572 Florida Agricultural and Mechanical Univ., Center for Nonlinear and Nonequilibrium Aeroscience, Tallahassee, FL USA
Shock Wave Dynamics in Weakly Ionized Gases, *1 Jun. 1997 - 31 May 1998*
Johnson, Joseph A., III, Florida Agricultural and Mechanical Univ., USA; 1998; 10p; In English
Contract(s)/Grant(s): NAG1-1930; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

We have begun a comprehensive series of analyses and experiments to study the basic problem of shock wave dynamics in ionized media. Our objective is to isolate the mechanisms that are responsible for the decrease in the shock amplitude and also to determine the relevant plasma parameters that will be required for a drag reduction scheme in an actual high altitude hypersonic flight. Specifically, we have initiated a program of analyses and measurements with the objective of (i) fully characterizing the propagation dynamics in plasmas formed in gases of aerodynamic interest, (ii) isolating the mechanisms responsible for the decreased shock strength and increased shock velocity, (iii) extrapolating the laboratory observations to the technology of supersonic flight.
Author
*Shock Waves; Ionized Gases; Drag Reduction; Flight Altitude; Fluid Dynamics; Supersonic Flight*

19980237910 Lockheed Martin Tactical Aircraft Systems, Fort Worth, TX USA
Analysis of Limit Cycle Oscillation/Transonic High Alpha Flow Visualization, Part 3, Oscillating Model Data *Final Report, Oct. 1994 - 1997*
Cunningham, Atlee M., Jr.; Geurts, Evert G.; Jan. 1998; 173p; In English
Contract(s)/Grant(s): F49620-94-C-0093; AF Proj. 2401
Report No.(s): AD-A353918; AFRL-VA-WP-TR-1998-3005-Pt-3; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

A flow visualization test was conducted with the simple straked wing in August, 1996 (at the National Aerospace Laboratory NLR, The Netherlands), for the purpose of obtaining flow visualization data to complement the pressure and force data base generated in earlier tests of the same configuration. This test was conducted in two parts to examine the flow field characteristics: (1) at high alpha conditions that involve vortices, shocks, and separated flows, and (2) at low alpha conditions typical of transonic LCO flows with and without tip stores. Laser light sheet/water vapor techniques were used to illuminate the flows, and video recording was used to obtain the data. Both low and high speed video cameras were used to examine spanwise and streamwise laser sheet positions. In addition, under NLR funding, some preliminary particle image velocimetry (PIV) data were obtained at M=0.225 and 0.6, as well as some pulsed laser flow visualization (9 nano-sec pulse) at M=0.9. Correlation was performed between

the flow visualization data from this test and the pressure/force data obtained in 1992 on the same configuration. This report contains the flow visualization results, for the oscillating model.
DTIC
*Flow Visualization; Transonic Flow; Separated Flow; Wing Oscillation*

19980237911 Lockheed Martin Tactical Aircraft Systems, Fort Worth, TX USA
Analysis of Limit Cycle Oscillation/Transonic High ALPHA Flow Visualization, Part 2: Stationary Model Data *Final Report, Oct. 1994 - 1997*
Cunningham, Atlee M., Jr.; Geerts, Evert G.; Jan. 1998; 165p; In English
Contract(s)/Grant(s): F49620-94-C-0093/7; AF Proj. 2401
Report No.(s): AD-A353919; AFRL-VA-WP-TR-1998-3004-Pt-2; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

A flow visualization test was conducted with the simple straked wing in August, 1996 at the National Aerospace Laboratory NLR, The Netherlands, for the purpose of obtaining flow visualization data to complement the pressure and force data base generated in earlier tests of the same configuration. This test was conducted in two parts to examine the flow field characteristics: (1) at high alpha conditions that involve vortices, shocks, and separated flows, and (2) at low alpha conditions typical of transonic LCO flows with and without tip stores. Laser light sheet/water vapor techniques were used to illuminate the flows, and video recording was used to obtain the data. Both low and high speed video cameras were used to examine spanwise and streamwise laser sheet positions. In addition, under NLR funding, some preliminary particle image velocimetry (PIV) data were obtained at M=0.225 and 0.6, as well as some pulsed laser flow visualization (9 nano-sec pulse) at M=0.9. Correlation was performed between the flow visualization data from this test and the pressure/force data obtained in 1992 on the same configuration. This report contains the flow visualization results for the stationary model.
DTIC
*Separated Flow; Transonic Flow; Wing Oscillations; Flow Visualization*

## 13
## GEOSCIENCES

*Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.*

19980237043 Korea Electric Power Corp., Taejon, Korea, Republic of
Development of Gas Turbine Output Enhancement System Using Thermal Ice Storage (I)
Choi, Byun Youn, Korea Electric Power Corp., Korea, Republic of; Joo, Yong Jin, Korea Electric Power Corp., Korea, Republic of; Lee, Kyoung Ho, Korea Electric Power Corp., Korea, Republic of; Lee, Jae Bong, Korea Electric Power Corp., Korea, Republic of; Kang, Myung Soo, Korea Electric Power Corp., Korea, Republic of; Kim, Kyung Soon, Korea Electric Power Corp., Korea, Republic of; 1997; 272p; In Korean
Report No.(s): TR-96[J31-97-60; DE98-766293; No Copyright; Avail: Issuing Activity, US Distribution and Sales Only; Microfiche

The objective of this study is to develop a system which enhances gas turbine output using ice storage in summer peak days for power supply stability in domestic power system. This study represents conceptual design, system optimization, basic design and economic analysis of system. General equations which represents capacity of chiller and storage tank were drive. Pyungtaek power plant was selected as one suitable for system application due to its space availability. The system was optimized on the basis of economic analysis and power supply situation by determination of optimal inlet cooling hour. TRNSYS simulation program was used for optimal operating factor of ice harvester under partial load operating conditions. Basic design includes capacity calculation of component, cost survey, system flow diagram, plot plan, and system guide. The system has been evaluated on the basis of economic analysis which calculates NPV, payback period and levelized generation cost.
DOE
*Air; Compressors; Cooling Systems; Ice; Storage Tanks; Gas Turbines; Fabrication; Heat Storage*

19980237454 NASA Goddard Space Flight Center, Greenbelt, MD USA
A Modernized Approach to Meet Diversified Earth Observing System (EOS) AM-2 Mission Requirements
Newman, Lauri Kraft, NASA Goddard Space Flight Center, USA; Hametz, Mark E., Al Solutions, Inc., USA; Conway, Darrel J., Al Solutions, Inc., USA; 1998; 15p; In English; 13th. Space Flight Dynamics, 11-15 May 1998, Greenbelt, MD, USA;

Sponsored by American Astronautical Society, USA
Report Number: AAS-98-300, No Copyright, Avail: CASI; A03, Hardcopy; A01, Microfiche

From a flight dynamics perspective, the EOS AM-1 mission design and maneuver operations present a number of interesting challenges. The mission design itself is relatively complex for a low Earth mission, requiring a frozen, Sun-synchronous, polar orbit with a repeating ground track. Beyond the need to design an orbit that meets these requirements, the recent focus on low-cost, "lights-out" operations has encouraged a shift to more automated ground support. Flight dynamics activities previously performed in special facilities created solely for that purpose and staffed by personnel with years of design experience are now being shifted to the mission operations centers (MOCs) staffed by flight operations team (FOT) operators. These operators' responsibilities include flight dynamics as a small subset of their work; therefore, FOT personnel often do not have the experience to make critical maneuver design decisions. Thus, streamlining the analysis and planning work required for such a complicated orbit design and preparing FOT personnel to take on the routine operation of such a spacecraft both necessitated increasing the automation level of the flight dynamics functionality. The Freef1yer(trademark) software developed by AI Solutions provides a means to achieve both of these goals. The graphic interface enables users to interactively perform analyses that previously required many parametric studies and much data reduction to achieve the same result. In addition, the fuzzy logic engine enables the simultaneous evaluation of multiple conflicting constraints, removing the analyst from the loop and allowing the FOT to perform more of the operations without much background in orbit design. Modernized techniques were implemented for EOS AM-1 flight dynamics support in several areas, including launch window determination, orbit maintenance maneuver control strategies, and maneuver design and calibration automation. The benefits of implementing these techniques include increased fuel available for on-orbit maneuvering, a simplified orbit maintenance process to minimize science data downtime, and an automated routine maneuver planning process. This paper provides an examination of the modernized techniques implemented for EOS AM-1 to achieve these benefits.
Author
*Earth Observing System (EOS); Mission Planning; Data Reduction; Aerodynamics; Data Processing; Flight Operations*

19980237712 Colorado State Univ., Dept. of Atmospheric Science, Fort Collins, CO USA
Analysis of Ice Nucleating Aerosol Measurements during SUCCESS: April, May 1996 *Final Report, 1 Jan. - 31 Dec. 1997*
Rogers, D. C., Colorado State Univ., USA; Kreidenweis, S. M., Colorado State Univ., USA; DeMott, P. J., Colorado State Univ., USA; Mar. 24, 1998; 5p; In English
Contracts/Grants: NAG2-1109; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

This section describes our research activities during year three of this effort. In the second year, preliminary archive data sets were submitted to the SUCCESS archive. After additional analyses, final versions were prepared and submitted. These are included on the SUCCESS CD-ROM data editions that were recently released by NASA Ames. Over the range of temperature and supersaturation conditions of our measurements (15 to -40 C, and from ice saturation to approximately 15% water supersaturations), IN concentrations ranged from less than 0.1 to approximately 500 per liter, being generally greater at colder temperatures and higher supersaturations. to estimate the potential of aircraft exhaust as a source of IN, we examined data from six days of the field project when the DC-8 was following closely behind other humidity conditions of our measurements. In April 1997, a microphysical workshop was convened at NCAR to select cases for in depth analyses and to address questions about the consistency of cloud ice crystal measurements (size distributions and mass concentrations) and aerosol size distribution. We attended this meeting and contributed to the discussions. A particular concern was identified in the CN measurements. On the DC-8, CN measurements were obtained by four different investigator groups, using commercially available instrumentation. The DC-8 SUCCESS CN data showed long periods where the measurements were in substantial agreement, but there were also periods with large discrepancies. Several possible factors were identified that could help explain these discrepancies, including minimum detectable particle size, response at reduced pressures, and location of sample inlet on the aircraft.
Derived from text
*Aerosols; Ice; Nucleation; Supersaturation; DC-8 Aircraft*

19980237963 NASA Goddard Space Flight Center, Greenbelt, MD USA
Aviation Fuel Tracer Simulation: Model Intercomparison and Implications
Douglass, M. Y., Atmospheric and Environmental Research, Inc., USA; Fahey, D. W., National Oceanic and Atmospheric Administration, USA; Schumann, U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Prather, M. J., California Univ., USA; Penner, J. E., Michigan Univ., USA; Ko, M. K. W., Atmospheric and Environmental Research, Inc., USA; Weisenstein, D. K., Atmospheric and Environmental Research, Inc., USA; Jackman, C. H., NASA Goddard Space Flight Center, USA; Pitari, G., Aquila Univ., Italy; Koehler, I., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Sausen, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Weaver, C. J., NASA Goddard Space Flight Center, USA; Douglass, A. R., NASA Goddard Space Flight Center, USA; Connell, P. S., Lawrence Livermore National Lab., USA; Kinnison, D. E., Lawrence

Livermore National Lab., USA; Dentener, F. J., Utrecht Univ., Netherlands; Fleming, E. L., NASA Goddard Space Flight Center, USA; Berntsen, T. K., Oslo Univ., Norway; Isaksen, I. S. A., Oslo Univ., Norway; Haywood, J. M., Meteorological Office, UK; Geophysical Research Letters; 1998; 10p; In English; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

An upper limit for aircraft-produced perturbations to aerosols and gaseous exhaust products in the upper troposphere and lower stratosphere (UTLS) is derived using the 1992 aviation fuel tracer simulation performed by eleven global atmospheric models. Key findings are that subsonic aircraft emissions: (1) have not be responsible for the observed water vapor trends at 40 deg N; (2) could be a significant source of soot mass near 12 km, but not at 20 km; (3) might cause a noticeable increase in the background sulfate aerosol surface area and number density, (but not mass density) near the northern mid-latitude tropopause; and (4) could provide a global, annual mean top of the atmosphere radiative forcing up to -0.0006 W/sq m and -0.013 W/sq m due to emitted soot and sulfur, respectively.

Author

*Aircraft Fuels; Atmospheric Models; Perturbation; Water Vapor; Aerosols; Stratosphere; Combustion Products; Exhaust Emission*

## 14
## LIFE SCIENCES

*Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology*

19990237931 Naval Postgraduate School, Monterey, CA USA

The Effects of Sopite Syndrome on Self-Paced Airsickness Desensitization Program

Flaherty, Michelle A.; Sep. 1998; 78p; In English

Report No.(s): AD-A354298; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The U. S. Navy implemented the Self-Paced Airsickness Desensitization (SPAD) program in 1989 for aviation students whose incidence of airsickness was not easily resolved. Some participants may have also experienced symptoms that are not typically recognized as motion sickness, including prolonged drowsiness and/or mood changes. These effects are part of a poorly understood response to motion termed "Sopite Syndrome." This thesis explores the effects of Sopite Syndrome on student aviators diagnosed with motion sickness. Sixty SPAD program participants completed a survey comprised of scales, which estimate motion sickness, drowsiness, fatigue, and sleep disturbances during SPAD treatment days. Results indicate: (1) symptoms consistent of Sopite Syndrome were reported by 45% of the participants and (2) the presence of Sopite Syndrome in a SPAD participant was not an accurate predictor for successful treatment and return to flight status.

DTIC

*Signs and Symptoms; Motion Sickness; Aircraft Pilots*

19990237938 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA

A Comparison of 8-Hour versus 12-Hour Shifts on Performance, Health and Safety in a USAF Aircraft Maintenance Squadron

Scott, Kelly J.; Sep. 1998; 63p; In English

Report No.(s): AD-A354347; AFIT/GLM/LAL/98S-11; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This study examined the effects of converting a large USAF aircraft maintenance squadron from an 8-hour shift system to a 12-hour shift system. In 1996, the squadron converted its 24-hour operations from three 8-hour work shifts, to two 12-hour work shifts with compressed work weeks. The squadron maintained 12-hour shifts for 19 consecutive months. A comparison was made of organizational performance, worker health and safety measures before, during and after 12-hour shift implementation. Findings indicated that changing from 8- to 12-hour shifts resulted in a slight increase in aircraft Mission Capability rates. However, this benefit appears to have come at the expense of worker health, ...: evidenced by a ten-fold increase in worker sick-call visits to the base hospital. Additionally, the squadron expended a higher proportion of direct labor hours in support of the flying schedule. There were no significant differences in any other aircraft reliability, maintenance repair or deferred maintenance indicators. On- and off-duty accident rates were also examined. There were no significant differences noted between mean 8- and 12-hour shift accident rates. The decision to implement 12-hour shifts is one that must be made with careful consideration of the costs and benefits identified in this study.

DTIC

*Aircraft Maintenance; Operator Performance; Health; Schedules*

## 15
## MATHEMATICAL AND COMPUTER SCIENCES

*Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.*

19980237199 Vigyan Research Associates, Inc., Hampton, VA USA
A Formal Model of Partitioning for Integrated Modular Avionics
**DiVito, Ben L., Vigyan Research Associates, Inc., USA; Aug. 1998; 86p; In English**
Contracts/Grants(s): NAS1-96014; RTOP 519-80-11-01
Report No.(s): NASA/CR-1998-208703; NAS 1.26:208703; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

**The aviation industry is gradually moving toward the use of integrated modular avionics (IMA) for civilian transport aircraft. An important concern for IMA is ensuring that applications are safely partitioned so they cannot interfere with one another. We have investigated the problem of ensuring safe partitioning and logical non-interference among separate applications running on a shared Avionics Computer Resource (ACR). This research was performed in the context of ongoing standardization efforts, in particular, the work of RTCA committee SC-182, and the recently completed ARINC 653 application executive (APEX) interface standard. We have developed a formal model of partitioning suitable for evaluating the design of an ACR. The model draws from the mathematical modeling techniques developed by the computer security community. This report presents a formulation of partitioning requirements expressed first using conventional mathematical notation, then formalized using the language of SRI'S Prototype Verification System (PVS). The approach is demonstrated on three candidate designs, each an abstraction of features found in real systems.**
**Author**
*Airborne Spaceborne Computers; Aircraft Industry; Avionics; Computer Information Security; Transport Aircraft*

19980237201 Cleveland State Univ., Cleveland, OH USA
Performance Analysis of an Actor-Based Distributed Simulation *Final Report*
**Schoeffler, James D., Cleveland State Univ., USA; Oct. 1998; 72p; In English**
Contracts/Grants(s): NCC3-461; NAG3-1441; RTOP 509-10-31
Report No.(s): NASA/CR-1998-208518; NAS 1.26:208518; E-11299; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

**Object-oriented design of simulation programs appears to be very attractive because of the natural association of components in the simulated system with objects. There is great potential in distributing the simulation across several computers for the purpose of parallel computation and its consequent handling of larger problems in less elapsed time. One approach to such a design is to use "actors", that is, active objects with their own thread of control. Because these objects execute concurrently, communication is via messages. This is in contrast to an object-oriented design using passive objects where communication between objects is via method calls (direct calls when they are in the same address space and remote procedure calls when they are in different address spaces or different machines). This paper describes a performance analysis program for the evaluation of a design for distributed simulations based upon actors.**
**Author**
*Computerized Simulation; Object-Oriented Programming; Computer Animation; Flight Simulation*

19980237929 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA
Software Support Cost Estimating Models: A Comparative Study of Model Content and Parameter Sensitivity
**Brummett, Kevin L.; Mischler, Philip, Jr.; Sep. 1998; 174p; In English**
Report No.(s): AD-A354293; AFIT/GCA/LAS/98S-3; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

**This research entailed a comparison of five software estimating models: PRICE-S, SEER-SEM, SoftCost-OO, SoftEst, and SPR KnowledgePLAN. The objective was to research the differences of the software models as related to software support cost. The following major question areas were addressed: (1) How do the differences between the models impact the resulting cost estimates? (2) to what degree can we explain and adjust for the differences between cost models? All items were for flight avionics**

of a manned aircraft. The differences between the models significantly impact the resulting estimates. Over the five models evaluated, a range of over $60 million occurred during a twenty year estimate. The researchers can explain the differences in the models due to the different algorithms used, but were not able to normalize the models to achieve equivalent estimates. The researchers feel a typical user will not be able to normalize separate models and should, therefore, concentrate on learning one or two models in detail. Different models are more appropriate depending on the task or project being estimated.
DTIC
*Applications Programs (Computers); Cost Analysis; Avionics; Cost Estimates*

## 16
## PHYSICS

*Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy; optics; plasma physics; solid state physics; and thermodynamics and statistical physics.*

19980237141 **NASA Lewis Research Center, Cleveland, OH USA**
Quantitative Interferometry in the Severe Acoustic Environment of Resonant Supersonic Jets
**Mercer, Carolyn R., NASA Lewis Research Center, USA; Raman, Ganesh, NYMA, Inc., USA; 1998; 7p; In English; 4th; High Speed Jet Flows, 21-25 Jun. 1998, Washington, DC, USA; Sponsored by American Society of Mechanical Engineers, USA**
**Contract(s)/Grant(s): RTOP 274-00-00; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche**

**There is renewed interest in the study of supersonic jets due to advances in high speed jet propulsion, supersonic combustion, and jet noise suppression for the next generation supersonic commercial transport. Understanding fundamental fluid dynamic and acoustic processes for these applications requires quantitative velocity, density and temperature measurements. In this paper we present data demonstrating a new, robust interferometer that can provide accurate data even in the presence of intense acoustic fields. This novel interferometer, the Liquid Crystal Point Diffraction Interferometer (LCPDI), was developed earlier for space flight experiments and is applied here to the case of a supersonic shock-containing jet. The LCPDI is briefly described, then integrated line-of-sight density data from the LCPDI for two underexpanded free jets are presented. The experimental shock spacings agree well with theory.**
**Author**
*Supersonic Transports; Supersonic Jet Flow; Supersonic Combustion; Noise Reduction; Jet Aircraft Noise; Jet Propulsion; Interferometry; Density Measurement; Acoustics*

19980237250 **NASA Goddard Space Flight Center, Greenbelt, MD USA**
Cryogenic Optical Performance of the Cassini Composite InfraRed Spectrometer (CIRS) Flight Telescope
**Losch, Patricia, NASA Goddard Space Flight Center, USA; Lyons, James J., III, NASA Goddard Space Flight Center, USA; Hagopian, John, NASA Goddard Space Flight Center, USA; 1998; 18p; In English; 8th; Cryogenic Optical Systems and Instruments, Jul. 1998, San Diego, CA, USA; Sponsored by International Society for Optical Engineering, USA; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche**

**The CIRS half-meter diameter beryllium flight telescope's optical performance was tested at the instrument operating temperature of 170 Kelvin. The telescope components were designed at Goddard Space Flight Center (GSFC) but fabricated out of house and then assembled, aligned and tested upon receipt at GSFC. A 24 inch aperture cryogenic test facility utilizing a 1024 x 1024 CCD array was developed at GSFC specifically for this test. The telescope,s image quality (measured as encircled energy), boresight stability and focus stability were measured. The gold coated beryllium design exceeded the cold image performance requirement of 80% encircled energy within a 460 micron diameter circle.**
**Author**
*Coatings; Cryogenics; Flight Characteristics; Image Resolution; Infrared Spectrometers; Operating Temperature; Telescopes; Test Facilities; Astronomical Observatories; Mirrors; Lenses; Optical Measuring Instruments; Seeing (Astronomy); Spaceborne Astronomy*

19980237569 **Duke Univ., Durham, NC USA**
Frequency and Time Domain Modeling of Acoustic Liner Boundary Conditions
**Bliss, Donald B., Duke Univ., USA; 1982; 18p; In English**
**Contract(s)/Grant(s): NAG1-1208; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche**

As part of a research program directed at the acoustics of advanced subsonic propulsion systems undertaken at NASA Langley, Duke University was funded to develop a boundary condition model for bulk-reacting nacelle liners. The overall objective of the Langley program was to understand and predict noise from advanced subsonic transport engines and to develop related noise control technology. The overall technical areas included: fan and propeller source noise, acoustics of ducts and duct liners, interior noise, subjective acoustics, and systems noise prediction. The Duke effort was directed toward duct liner acoustics for the development of analytical methods to characterize liner behavior in both frequency domain and time domain. A review of duct acoustics and liner technology can be found in Reference [1]. At that time, NASA Langley was investigating the propulsion concept of an advanced ducted fan, with a large diameter housed inside a relatively short duct. Fan diameters in excess of ten feet were proposed. The lengths of both the inlet and exhaust portions of the duct were to be short, probably less than half the fan diameter. The nacelle itself would be relatively thin-walled for reasons of aerodynamic efficiency. The blade-passage frequency was expected to be less than 1 kHz, and very likely in the 200 to 300 Hz range. Because of the design constraints of a short duct, a thin nacelle, and long acoustic wavelengths, the application of effective liner technology would be especially challenging. One of the needs of the NASA Langley program was the capability to accurately and efficiently predict the behavior of the acoustic liner. The traditional point impedance method was not an adequate model for proposed liner designs. The method was too restrictive to represent bulk reacting liners and to allow for the characterization of many possible innovative liner concepts. In the research effort at Duke, an alternative method, initially developed to handle bulk reacting layers as described in Reference [2], was extended to apply to a broad range of liner types. This method included the effect of local gradients along the liner surface, and was particularly appropriate for situations with flow over the liner and grazing incidence acoustic fields. In order to utilize time domain computational methods to solve for the propfan acoustic field, corresponding liner boundary conditions were developed for time domain solutions rather than frequency domain solutions.

Author

*Acoustics; Boundary Conditions; Sound Waves; Noise Prediction; Acoustic Ducts; Aerodynamic Noise*

19980237714 NASA Lewis Research Center, Cleveland, OH USA

Modeling the Response from a Cascade to an Upstream Acoustic Disturbance

Paynter, Gerald C., Boeing Co., USA; Clark, Larry T., Boeing Co., USA; Cole, Gary L., NASA Lewis Research Center, USA; 1998; 18p; In English; 36th; Aerospace Sciences, 12-15 Jan. 1998, Reno, NV, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): RTOP 022-00-00

Report No.(s): AIAA Paper 98-0953; No Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

Time-accurate Euler flow field simulations for the flow through a two-dimensional cascade subjected to an up-stream acoustic disturbance were used as the basis for a small disturbance model to predict the reflected response up-stream of the cascade. The small disturbance model results in a linear system of algebraic equations for the properties of the reflected and transmitted disturbances. The model predicts the reflected and transmitted responses as a function of the cascade blade geometry, the disturbance strength, and the initial flow properties prior to the upstream disturbance. The predicted results from the small disturbance model were then compared with the Euler analysis results for a two-dimensional cascade. Agreement between the model and the Euler data indicated that the model was potentially useful as a basis for an outflow boundary condition for time-accurate Euler/Navier-Stokes (ENS) simulations of supersonic mixed compression inlet flows needed to determine the stability margin of an inlet that encounters an atmospheric disturbance. This boundary condition must provide an approximation of the response from the compressor by the inlet flow at the face of the compressor when a disturbance from upstream passes through the inlet and into the compressor. A new characteristic boundary condition based on the small disturbance response model was formulated and demonstrated independently in two one-dimensional Euler codes. The one-dimensional Euler codes with the new boundary condition and with existing boundary condition formulations were used to predict the reflection response for an axial compressor experiment. The new boundary condition was found to provide a significant improvement in accuracy for the reflection response of an acoustic disturbance from a compressor relative to existing outflow boundary condition models. For a supersonic mixed compression inlet, a one-dimensional Euler code was also used to demonstrate the dependence of the inlet normal-shock response and unstart tolerance on the outflow boundary condition.

Author

*Euler Equations of Motion; Turbocompressors; Navier-Stokes Equation; Multiphase Flow; Inlet Flow; Free Flow; Flow Characteristics; Compressors; Boundary Conditions*

## 18
## SPACE SCIENCES

*Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.*

19980237136 NASA Langley Research Center, Hampton, VA USA

Numerical Roll Reversal Predictor-Corrector Aerocapture and Precision Landing Guidance Algorithms for the Mars Surveyor Program 2001 Missions

Powell, Richard W., NASA Langley Research Center, USA; 1998; 9p; In English; Atmospheric Flight Mechanics, 10-12 Aug. 1998, Boston, MA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Report No.(s): AIAA Paper 98-4574; Copyright; Avail: Issuing Activity; Hardcopy; Microfiche

This paper describes the development and evaluation of a numerical roll reversal predictor-corrector guidance algorithm for the atmospheric flight portion of the Mars Surveyor Program 2001 Orbiter and Lander missions. The Lander mission utilizes direct entry and has at demanding requirement to deploy its parachute within 100 km of the target deployment point. The Orbiter mission utilizes aerocapture to achieve a precise captured 10 orbit with a single atmospheric pass. Detailed descriptions of these predictor-corrector algorithms are given. Also, results of three and six degree-of-freedom Monte Carlo simulations which include navigation, aerodynamics, mass properties and atmospheric density uncertainties are presented.

Author

*Predictor-Corrector Methods; Parachutes; Monte Carlo Method; Degrees of Freedom; Atmospheric Density; Aircraft Landing; Aircraft Guidance; Aerocapture*

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